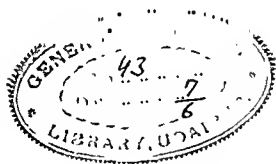


ABDOMINAL
OPERATIONS
VOLUME I



ABDOMINAL OPERATIONS

BY

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VOLUME I



D. APPLETON-CENTURY COMPANY
INCORPORATED
NEW YORK LONDON

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✓ 1825
24.1.64

PRINTED IN THE UNITED STATES OF AMERICA

TO MY WIFE
No. 1. N5

PREFACE

This book is intended to present a detailed consideration of the technique of modern abdominal operations.

It also deals with the choice of operation in the individual case, the difficulties and dangers which sometimes arise during the conduct of operation, the pre- and post-operative treatment, the immediate and remote results of the various measures described, the clinical, pathological and other aspects of most of the destructive lesions of the abdominal viscera, and many problems in abdominal surgery.

It is hoped that this work will appeal to the abdominal surgeon, to the general surgeon who specialises—as many of them do—in surgery of the abdomen, to the senior student who is studying for the higher degrees in surgery, to resident surgeons holding responsible posts on the staffs of hospitals, to medical officers in the fighting Services, and to all those who are interested in present-day developments in surgery.

I tender my most cordial and grateful thanks to the publishers for their help in the arrangement of this work, for their readiness to adopt my suggestions, and above all for overcoming every obstacle in order that success might be achieved;

To the many authors and publishers who have generously allowed me to quote important passages from their works, to abstract valuable statistical data, or to adapt certain illustrations, the full acknowledgments of which are duly made in the text, captions or footnotes;

To the surgeons in this country and abroad who have so kindly extended to me the privilege of witnessing their work;

To those who have so readily assisted me with the loan of many useful illustrations and skiagrams;

To Dr. R. Sleigh Johnson for his valuable contribution on Post-Operative Chest Complications, and to Dr. L. T. Bond for his learned and instructive treatise on Sternal Puncture.

The illustrations with a few exceptions have been specially drawn for me by Miss Pauline Larivière, formerly of McGill University and

at one time a pupil of that great artist, Max Brödel. Her work constitutes one of the outstanding features of the book. The majority of her drawings are original and were sketched by my side in the operating room. It has been her aim not only to portray faithfully the individual steps of the various procedures detailed, but also to present studies which are lifelike, vivid and anatomically correct. My warmest thanks are due to her, and also to Mr. W. Thornton Shiells who has been responsible for most of the coloured illustrations of pathological specimens and also for some of the drawings depicting operations upon the colon and the rectum.

To my secretary, Miss A. M. Cosham, I owe a great debt of gratitude for helping me with every step of this work, for typing and correcting the manuscripts, for reading the proofs with me at the end of the day's work, and for her enthusiasm and encouragement during our joint labours.

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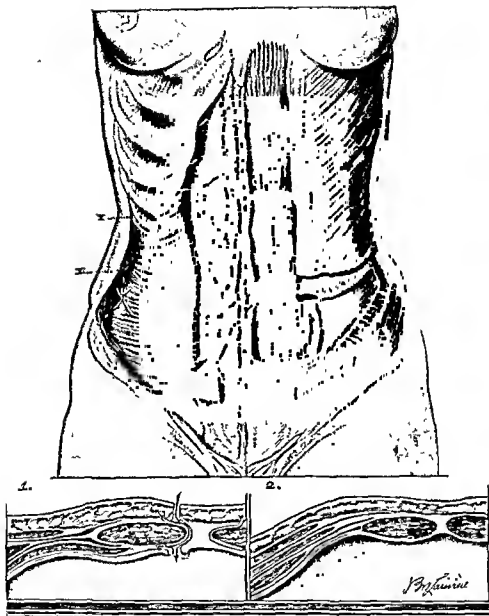
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PART I

ABDOMINAL INCISIONS



ANATOMICAL STUDY DEPICTING THE MUSCULAR AND APONEUROTIC DISTRIBUTION AND THE NERVE AND BLOOD SUPPLY OF THE ANTERIOR ABDOMINAL WALL.

(1) Illustration of a transverse section of the anterior abdominal wall above the umbilicus.

(2) Illustration of a transverse section of the anterior abdominal wall below the semilunar fold of Douglas.

CHAPTER 1

GENERAL REMARKS AND PRINCIPLES

It is probably no exaggeration to state that in abdominal surgery wisely chosen incisions and correct methods of making and closing such wounds are factors of paramount importance. Any mistakes here, such as a badly placed incision, a careless disregard of the motor nerves which supply the abdominal muscles, inept methods of suturing, or omitting to protect the wound from contamination during operation may result in serious complications such as infection or disruption of the wound, stitch abscess, a weakened scar, an ugly raised keloid, or a tell-tale rupture. It should be the surgeon's duty to employ that type of incision which he considers to be the most suitable for the particular case with which he is dealing, and also to suture the wound efficiently *himself* instead of relegating this most important step to an assistant, a practice which is becoming increasingly popular in certain clinics, and which is, in my opinion, one greatly to be deplored. An assistant, capable though he may be, may not possess the knowledge which the surgeon has acquired by experience. For example, in certain types of patients, more especially the obese, and in certain diseases which call for emergency measures, such as acute appendicitis, the recognised routine methods of incision and closure of the abdominal wall may not be applicable and the success of the particular operation will, in no small measure, depend upon the size and the judicious placing of the incision and upon a wise selection both of suture material and of the method of closure to be adopted. This advice should be given serious consideration in view of the fact that such complications as have already been mentioned frequently follow in the wake of abdominal operations. Eliason and McLaughlin, for instance (*Ann. Surg.*, 100:1159, 1934) state that a review of the literature shows that wound complications occur in approximately 10 per cent of all *clean* cases, and they consider that in this day of aseptic surgery, of intensive pre-operative preparation of the surgical field, of highly developed technique of

closure, and of skilful post-operative care, such an incidence, occurring even in the best surgical clinics in the world, is surprisingly high. Sokolov (*Vestnik Khir.*, 65:219, 1931), who analysed the replies which he received from 1,000 questionnaires circularised to surgeons in various parts of Central Europe, came to the conclusion that the incidence of disruption of the abdominal wound was about 2 per cent. Singleton studied 900 cases reported from several hospitals in America and found a total mortality of 38 per cent from disruption alone.

The incidence of post-operative hernia in fat patients is distressingly common, and subsequent operations directed to the cure of such defects in the abdominal wall are laboriously tedious, highly specialised, and not without risk to the patient's life. In cases of frank sepsis of the wound, and especially where prolonged drainage of the abdominal cavity has been employed, incisional hernia is such a frequent and almost inevitable sequel that it requires no emphasis here.

At the present time it would be well nigh impossible for any surgeon to devise an entirely original abdominal incision which would strictly fulfil all anatomical and surgical requirements. Nowhere in the whole field of surgery is the ingenuity—and in certain instances the fatuity—of the surgeon more fittingly displayed than in the number of incisions which have at one time and another been invented. These have varied in site, size and shape, and in the complexity of the methods employed for their closure. For instance, for operations upon the gall-bladder alone, incisions have been made vertically, transversely, obliquely or to assume the distorted form of certain alphabetical characters such as Γ , \perp , \neg , ζ , ∇ .

The incisions chiefly used nowadays for exploring the abdominal cavity may be described under the following headings:

1. **Vertical.** These are median (midline) or paramedian incisions, and are made in the upper abdominal (supra-umbilical) or lower abdominal (infra-umbilical) region.
2. **Transverse.** These are placed above or below the umbilicus.
3. **Oblique.** These are lateral abdominal incisions, the best examples being Kocher's and McBurney's.

The *principles* which govern all abdominal incisions may be enumerated as follows:

1. The incision must give ready and direct access to the part to be investigated. A satisfactory operative field, however, results not only from a well made incision but also from the apt use of retractors, forceps and packs, correct posture of the patient on the operating table, efficient illumination, and a well-administered anæsthetic.

2. There should be the minimal amount of damage to the various layers of the abdominal wall. Muscles should, therefore, if possible, be separated rather than cut, bleeding must be effectively controlled, and nerves must not be severed.

3. The incision should be so placed anatomically that it can be enlarged if necessary without producing needless damage to the abdominal wall.

4. The closure of the wound must be reliable, and should leave the abdominal wall as strong after the operation as before. In order to ensure this and thus safeguard against the possibility of ventral hernia, the individual layers of the wound should be approximated accurately and without tension so as to afford ready healing, and dead spaces should be obliterated.

5. A good cosmetic result should be aimed at by employing the methods adopted by the plastic surgeon.

The *choice* of the incision depends upon so many factors, *e.g.*, the organ to be investigated, whether the disease is acute or chronic, whether speed is an essential consideration, the build of the patient, the thickness of the abdominal wall, the degree of relaxation obtainable, the accuracy of the diagnosis, the presence of multiple lesions or of unforeseen complications, etc., that it would be impossible to lay down any hard and fast rules; but when subsequently describing the individual incisions an attempt will be made to guide the surgeon in his choice.

In a general way, however, it may be stated that operations upon the stomach and duodenum are best conducted through a vertical median epigastric, an upper paramedian, or a transverse incision, in the order mentioned.

The spleen is usually approached through a left upper paramedian incision, although in obese patients a left sub-costal incision may be preferred. For operations upon the pancreas, adequate exposure is afforded by a transverse epigastric incision, as recommended by Whipple, although a vertical one is preferred by many surgeons.

For operations upon the gall-bladder and biliary passages, the incision of choice is a right upper paramedian or a Kocher oblique paracostal. Complicated flap incisions or those which traverse the danger zone of the outer border of the rectus muscle should be condemned.

For exploration of the pelvic organs the lower paramedian incision is preferable to the midline sub-umbilical, although in certain instances Pfannenstiel's transverse incision in the interspinous wrinkle possesses distinct advantages, as will be shown later.

In cases of chronic appendicitis, a right lower paramedian incision is probably the best to employ in women, as the cæcum, the appendix, and the lower coils of the ileum are readily accessible to scrutiny, as are also the pelvic organs. In all cases of acute appendicitis in which the diseased organ is known to be lying centrally or low down in the pelvis, this method of approach cannot be bettered. McBurney's incision, or some modification of it, is the one chosen by most surgeons for appendicectomy in acute cases, the incision being made directly over the diseased organ, or over the structures in its immediate neighbourhood when these are palpable. An extensive gridiron incision, or preferably a lateral oblique abdominal incision which divides the layers of the abdominal wall in a line with the incision, may in certain instances be advantageously employed to explore the ascending colon, especially in cases of carcinoma, and when the incision is placed on the left side an excellent view of the descending colon and the sigmoid portion of the large intestine is afforded (Kocher).

In acute upper abdominal catastrophes the abdomen is best investigated through a vertical midline epigastric incision, while in acute diseases involving the lower abdomen, the right lower paramedian incision is chosen. When it is known that an acute intra-abdominal lesion exists but its exact situation cannot be determined by any of the means available, the rectus muscle should be drawn aside through a right paramedian incision, 4 inches in length and placed half above and half below the umbilicus, thereby securing adequate access to every recess in the abdominal cavity for exploratory purposes.

Vertical transrectus, or so-called muscle-split incisions, in fact any vertical incisions which are not strictly median or paramedian,

should be avoided, as by their use the part of the rectus muscle medial to the incision is deprived of its nerves and rapidly disappears by atrophy. Lengthy incisions through the linea semilunaris are particularly maleficent, as the cut passes at right angles to the course of the motor nerves supplying the rectus muscle, inevitably severing many of them, with the result that the rectus, and in certain cases even adjacent portions of the large flat abdominal muscles, become partially or wholly paralysed, waste, thin out and bulge, often resulting in a hernia of varying proportions.

Battle's pararectal incision is still widely used for exposing the appendix, and is made a little to the outer side of the middle of the right rectus. The wound is deepened and the anterior sheath of the rectus is opened for the full length of the incision. The lateral edge of the sheath is clipped with forceps, and the muscle mobilised medially, after which the assistant retracts the muscle toward the middle line using the index finger, as metal retractors tend to wound the deep epigastric vessels and cause troublesome hæmorrhage. After retracting the nerves which enter the deep aspect of the rectus, the peritoneum is opened. This incision has many drawbacks: the epigastric vessels may be injured when the belly of the muscle is being dissected free from the rectus sheath, during retraction, or while the peritoneum is being sutured. Damage to the deep epigastric vein may have fatal consequences in that it may initiate clotting in the vein and thus lead to pulmonary embolism. If drainage tubes have been inserted into the abdominal cavity they may press upon and erode these vessels and produce severe bleeding which may necessitate opening up the wound and ligating the vessels both proximally and distally. The wound cannot be extended for any great length without seriously injuring the motor nerves, two or three of which will have to be retracted out of harm's way while the peritoneum is being opened. If considerable retraction of the wound proves to be necessary, some of these nerves may be unduly stretched or damaged, or they may even snap and lead to partial atrophy of the lower portion of the rectus muscle. The exposure, too, cannot be compared to that which is obtained through the lower paramedian incision, in fact it is, to my mind, one of the most unphysiological of all abdominal incisions in common use today in hospitals all over this country and abroad.

DETAILS IN THE TECHNIQUE OF MAKING AND
CLOSING ABDOMINAL INCISIONS

General Remarks. When the patient is fully anaesthetised and has been placed upon the operating table, the preliminary dressings are removed and an area extending from the nipples to the upper thirds of the thighs and including the flanks is fully exposed and lavishly painted with the solution selected by the surgeon.

The number of antiseptic solutions which have been used for sterilising the skin of the abdominal wall are legion, and at one time or another the following have been advocated: tincture of metaphen (Abbott), mercurochrome-acetone-alcohol, picric acid, acriflavine, gentian violet, hexylresorcinol, merthiolate, tannin-alcohol (acid tannic 7.5 per cent in industrial spirit), and absolute alcohol. But as it has been proved by numerous workers that no antiseptic yet proposed has shown any superiority over tincture of iodine, this is still the antiseptic of preference in many clinics throughout the world.

In preparing the abdominal field the whole area should be thoroughly swabbed with ether, after which 2.5 per cent tincture of iodine is applied and allowed to dry. This area is then painted with alcohol immediately before the skin incision is made. This method of preparation has been found adequate in most cases. For this painting it is most important to hold the swab, which has been soaked in the solution, in a long swab-holder or ring forceps so that no portion of the surgeon's gloves or sleeves may come into contact with the patient's skin while the operative field is being prepared.

Towels or drapes are next applied in such a way that only the small area of skin through which the incision is made can be seen. It is essential that the hands of neither the surgeon nor his assistant should touch the skin of the abdominal wall while the incision is being made, or, indeed, during any stage of the operation.

Before making the incision, a series of transverse scratches is made with a fine straight needle, parallel to one another and about 1 inch apart across the proposed line of incision, to ensure that when the skin is sutured the Michel clips or sutures are inserted symmetrically at regular intervals and with mathematical precision. The incision itself is made with a clean firm sweep of the knife. There must be no

bungling, or a jagged, irregular cut will result which will afterward appear unsightly.

The points, and only the points, of all bleeding blood vessels in the subcutaneous tissues should be picked up with the tips of pointed artery forceps and immediately tied with fine plain catgut or the finest silk before the skin towels or tetra-cloths are affixed to the margins of the wound. The smaller the amount of tissue clipped with the blood vessels, the less sloughing there will be and the less likelihood also of stitch abscess or suchlike complications.

The knife which has been used to make the incision in the skin should be discarded and another one employed for completing the dissection. This prevents the carrying of infection from the skin surface to the depths of the wound. Similarly, all instruments which are used in making the incision down to but not through the peritoneum should be laid aside as contaminated and not be employed again during the operation.

In vertical epigastric incisions the peritoneum should be opened at the bottom end of the incision to avoid the falciform ligament of the liver, while in sub-umbilical vertical incisions the peritoneum should be incised in the upper part to avoid injury to the bladder. The peritoneum should always be opened with the greatest care, particularly if the patient is taking the anæsthetic badly and is straining or if there is any abdominal distension, as it is then so easy to puncture the intestine which may be lying hard and fast up against the peritoneum. A safe method is to pick up a fold of peritoneum with dissecting forceps, shake it to ensure that no other structure has been caught up with it, clip it with a hæmostat, and then divide this raised fold with the utmost care, using a knife with its blade held on the slant. This small opening is then enlarged to admit two fingers, which are used to protect the underlying viscera while the peritoneum is being divided throughout the whole length of the wound. Pains must be taken during intra-abdominal manipulations, when retracting the edges of the wound, and when introducing packs into the abdominal cavity, not to injure the delicate endothelial lining of the peritoneum, as this would predispose to shock and to post-operative adhesions.

Except in certain instances which will be described later, it is best to close the abdominal wound in layers, using a continuous suture of

No. 0 or No. 1 twenty-day chromic catgut for the peritoneum, a continuous suture or interrupted sutures of the same material for the aponeurosis, and the finest plain catgut for approximating the subcutaneous tissues, the skin edges being brought together with interrupted sutures of silkworm gut, silk, or clips, or with a combination of any two of these.

In certain clean cases the individual layers of the abdominal wall may be closed with interrupted or continuous sutures of fine silk—Halsted's silk technique (fig. 1).

It is a wise precaution in certain cases to insert a few supporting, tension, or "stay" sutures of strong silkworm gut or silk in order to guard against the possibility of wound dehiscence. When the last suture has been introduced, the wound is again freely painted with the same antiseptic solution which was employed in preparing the abdominal field before the operation, and the dressings are then applied.

DESCRIPTION OF INDIVIDUAL INCISIONS

1. **Vertical Incisions.** *Midline Epigastric Incision.* Most operations upon the stomach, duodenum and pancreas can be performed through this incision which possesses certain advantages in that it is almost bloodless, no muscle fibres are divided, no nerves are injured, and it affords good access to both sides of the upper abdomen. It is very quick to make and to close, and is therefore unsurpassed where speed is essential. Its main disadvantage is that there is a great tendency for the scar to stretch, as here the cleavage lines of Langer run transversely and there is considerable lateral pull in the epigastrium. Ventral hernia is said to occur more frequently with this incision than with the upper right paramedian, and this is probably true as the former is more often used for emergency operations, e.g., suture of a perforated peptic ulcer.

The incision is placed exactly in the midline, and extends from the tip of the xiphisternum to about $\frac{1}{2}$ inch above the umbilical cicatrix, dividing the skin, subcutaneous tissues, linea alba, fascia transversalis, extraperitoneal fat and peritoneum. The extraperitoneal fat is abundant and vascular in the upper half of the incision, and the suspensory ligament of the liver is best avoided by opening the peritoneal cavity well to the left of the midline under the belly

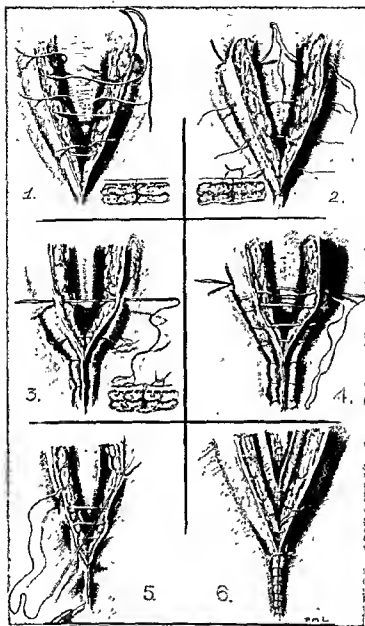


FIG. 1.—TYPES OF SKIN SUTURES AND OTHER SUTURES.

- (1) Inverted interrupted sutures for approximating the subcutaneous tissues.
- (2) Simple interrupted sutures for approximating the subcutaneous tissues and skin edges.
- (3) Interrupted vertical mattress sutures.
- (4) Continuous vertical mattress suture.
- (5) Subcuticular suture.
- (6) The method of closing all the layers of the abdominal wall with fine interrupted silk sutures in clean cases—Halsted's silk technique.

of the rectus muscle. If this ligament interferes with the exposure of the stomach or duodenum, or cramps the surgeon's movements in any way, it should be clamped in two places, divided and ligated.

The wound may be closed in a variety of ways, four of which will now be described:

METHOD I. By this method, which was frequently used by Stiles and by Wilkie, additional security may be obtained by making a vertical incision into each anterior rectus sheath, about $\frac{1}{2}$ inch from the midline, and dissecting these inner portions of the sheath away from the underlying muscle. The edges of the peritoneum and linea alba are approximated by a continuous suture, threaded through with a cutting needle, after which figure-of-eight sutures of stout silkworm gut are inserted at regular intervals, picking up the rectus sheath in the manner depicted in figure 2 [2]. The skin edges are then stitched together, after which the figure-of-eight tension sutures are threaded through short lengths of fine rubber tubing and snugly tied. The suture line is in this way protected from any lateral pull, thus guarding against ventral hernia.

METHOD II. Special wound hooks, as illustrated in figure 2 [4], are placed one at each end of the incision and forcibly lifted upward by an assistant so as to draw the edges of the wound as far away as possible from the underlying viscera. A series of strong silkworm gut sutures are then inserted through *all* the layers of the abdominal wall, about $\frac{3}{4}$ inch apart and about the same distance away from the margin of the skin on either side. As each is introduced, its ends are clipped and drawn taut. The edges of the peritoneum and linea alba are seized with artery forceps and stitched with a continuous catgut suture, again using a cutting needle. When this layer has been inserted, the through-and-through sutures of silkworm gut are threaded through small pieces of rubber tubing and tied, the assistant meanwhile maintaining the upward traction on the wound hooks. When the last suture has been tied, the hooks are removed, and the skin edges between the tension sutures are brought together with Michel clips or interrupted sutures of fine silkworm gut or silk.

METHOD III. In certain cases when speed is an essential factor this incision may be closed by a series of figure-of-eight sutures of strong silkworm gut embracing *all* the layers of the abdominal wall, as shown in figure 2 [5]. McNeill Love's rubber guard may be inserted



H. Williams

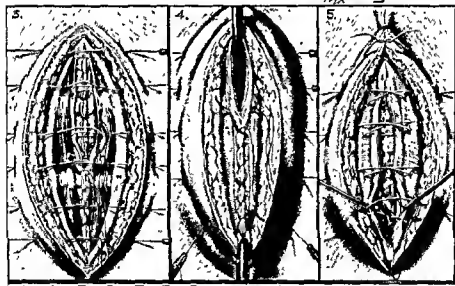


FIG. 2.—MIDLINE VERTICAL EPIGASTRIC INCISION.

- (1) The line of the incision.
- (2) Method of opening the peritoneal cavity.
- (3) Wilkie's method of closure of the wound.
- (4) Closure of the wound with through-and-through interrupted sutures and a continuous suture for uniting the edges of the linea alba. The hook retractors are in position.
- (5) The incision is closed with a series of interrupted figure-of-eight through-and-through sutures.

between the viscera and the abdominal wall to facilitate the introduction of these sutures. This guard is oval in shape, being about 6 inches long by 4 inches wide, and is cut from hard india-rubber such as is used for the inner tubing of a motor tyre. It has a strong piece of tape fixed to a hole at one end so as to facilitate its withdrawal before the last suture or two is tied.

METHOD IV. The method of closure of abdominal wounds by means of wire alone has been used for many years, and would appear to be particularly indicated for all wounds in which evisceration is prone to occur, *e.g.*, in cases of advanced visceral cancer or where the patient is very anæmic or debilitated, for those cases in which it is necessary to close the wound under great tension, *e.g.*, general peritonitis and acute intestinal obstruction, and in cases where a generalised infection of the wound is likely, *e.g.*, perforated diverticulitis.

Different types of wire of varying gauges have been used at various times, and these include German-silver wire (Reid), phosphor-bronze wire, Pilling wire, bronze wire (Pauchet), and "nickeline" (Mfinine and Voskresenski), while Babcock favoured rustless alloy of stainless steel wire (noble metal). In Okkels' opinion the most suitable alloys are chrome steel and duralumin, but my preference at the present time is for bronze wire of No. 24 standard wire gauge, as this is cheap, strong, flexible and dependable. The method of inserting lengths of this wire and using them as through-and-through stay sutures is very simple, and any incision can be closed in as little as two to three minutes, especially when the technique has been well mastered. Reid, Zinninger and Merrell (*Ann. Surg.*, 98:890, 1933) have pleaded with eloquent cogency for a more extended trial of this method of closure of abdominal wounds.

When it is intended to close a midline incision with wire, it is a helpful preliminary to make three longitudinal parallel scratches on the skin with a straight needle, the central scratch indicating the line of incision, the two lateral scratches being placed about $\frac{3}{4}$ inch away on either side of the central one. A series of transverse scratches is then made with the needle, again about $\frac{3}{4}$ inch apart, bisecting the three parallel longitudinal ones. The points at which the cross scratches intersect the longitudinal ones would indicate precisely the points of entry and exit for the needle or of the "aiguille sabre" of Victor Pauchet which I use for passing the wires (fig. 3).

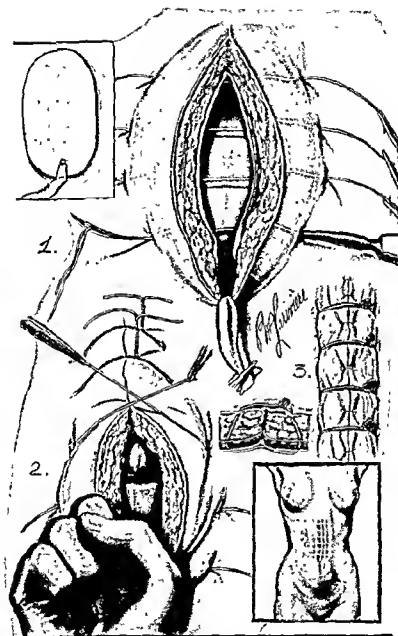


FIG. 3.—THE STEPS OF SUTURING AN ABDOMINAL INCISION BY THE WIRE METHOD.

The extremities of the wound are then picked up with Littlewood forceps or elevated with wound hooks, and Pauchet's needle is inserted, starting at the upper end of the wound on the left-hand side at the point of entry marked on the skin, and piercing all the layers of the abdominal wall in such a way as to take a good bite of muscle. The needle is then guided by the finger through the peritoneum and across the middle line, being made to transfix all the layers of the right margin of the wound, and emerging at a corresponding point on the right-hand side of the wound. The Pauchet needle is then threaded with a length of wire about 8 inches long, one end of the wire being flattened around the eye of the needle with the fingers or forceps. The needle is then withdrawn, bringing the wire with it, after which both ends are clipped with hæmostats and temporarily laid aside. This process is repeated until some six or eight lengths of wire have been introduced at regular intervals according to the skin markings.

The wound is next closed by pulling up and twisting each wire separately, starting at the upper end of the incision. The assistant pulls on the forceps at each end of one suture while the surgeon inserts the forefinger of his right hand inside the abdomen and reports when the wire is pulled sufficiently tight to bring the peritoneal edges firmly together. The wire is then twisted while the peritoneal edges are forcibly everted with the finger (fig. 3 [2]). The correct tension on the wire must be attained before the surgeon instructs the assistant to commence the twisting. The wire is twisted some six to eight times just above one of the openings through which it emerges, but not over the line of the incision. Each wire is pulled up in succession and twisted, precautions being taken to prevent a portion of omentum, stomach or colon from being ensnared in the wire, and to ensure that the tension of each wire is such as will secure a firm approximation of all the layers of the wound and eversion of the edges of the peritoneum.

When all the wires have been twisted they are individually cut with a clipper at a point just distal to the last twist, the ends of the wires being crushed with a hæmostat and pressed together so that there are no sharp ends to scratch the skin or to become entangled in the dressings. If an accurate skin-edge approximation is desired, a few Michel clips or interrupted sutures may be inserted between

each wire (fig. 3 [3]). The wires are not threaded through portions of rubber tubing prior to twisting, as this in practice appears to have no special advantage in preventing cross-hatching of the wound.

The following *objections* have been raised against the wire method of closure of abdominal wounds:

(a) That more pain is experienced when wires are used than when ordinary methods of closure are employed.

(b) That infection is very prone to occur around the wire.

(c) That as the wires are inserted under considerable tension they cut into the skin and leave an ugly cross-hatching of the wound.

(d) That as the peritoneum is not sutured, incisional hernia, intestinal obstruction, or crippling intra-peritoneal adhesions may follow.

(e) That a block slough of the abdominal wall is a possibility.

The *advantages* of this method may be enumerated as follows:

(a) The closure is most secure, in fact so secure that even cachectic and decrepit patients may be allowed to get out of bed at a very early stage after operation.

(b) Ventral hernia does not occur so frequently as it does after other and more formal types of closure have been employed for the same types of cases.

(c) The abdominal wall can be closed very rapidly and under tension, which is a great advantage in cases of burst abdomen or intestinal obstruction, or when other methods of suture have failed.

(d) The wound can be rapidly reopened by untwisting the wires if a second laparotomy is necessary shortly after the original one.

(e) In cases of peritonitis, drainage tubes are not required as there is a free discharge between the wires.

(f) The absence of any suture material such as catgut in the line of closure of a contaminated incision favours more kindly healing and renders infection less likely.

(g) Disruption of the abdominal wound cannot occur.

(h) Cosmetic results are surprisingly satisfactory.

The suggestion that, as the peritoneum is incompletely closed, intestinal obstruction or post-operative hernia may develop is, in my opinion, unwarranted, as such complications have not been experienced in practice. The possibility of a block slough of the wound has arisen in certain cases where the wires have been drawn too tightly,

but by untwisting them a little the congested and œdematous area will soon regain its normal appearance. The wires are removed on the twelfth to the eighteenth day after operation by cutting the loop and withdrawing the wire.

Upper Paramedian Incision. This incision may be made on the right or left side of the midline in the epigastrium. It is employed on the right side for operations upon the stomach, duodenum, gall-bladder and biliary passages, and pancreas, and on the left for cases of cancer of the stomach and for splenectomy. The incision is a vertical one, starting at the costal margin and finishing about 1 inch or so below the umbilicus, being placed 1 to 2 inches from the midline.

When the anterior sheath of the rectus has been exposed, it is incised for the whole length of the wound, after which the inner portion of the rectus sheath is carefully dissected from the lineae transversae to permit of the belly of the muscle being drawn outward (fig. 4 [1]). The posterior sheath of the rectus, the transversalis fascia and the peritoneum are then incised vertically, again for the whole length of, and in a line with, the skin incision. In this way a trap-door incision is made.

It is essential to start the incision at the costal margin just to one side of the xiphisternum, as efficient access to the gall-bladder cannot be obtained unless the upper portion of the muscle is dislocated. This incision fulfils all anatomical and physiological requirements, as it gives direct access to the organ to be investigated, *e.g.*, the stomach; no muscles or nerves are divided, it can be enlarged to the pubis if desired, and, if efficiently sutured, it is not followed by any weakness.

The posterior sheath of the rectus must be caught up with the peritoneum when the edges of the peritoneum are being closed by a continuous suture and by interrupted mattress sutures, as if it is not included the most important layer, *i.e.*, the transversalis fascia which lies between the posterior sheath and the peritoneum, will not be sutured, and thus one of the principal precautions in the prevention of the formation of incisional hernia will be neglected.

There are many methods employed for suturing the peritoneum. It may be closed with a continuous through-and-through suture plus a few interrupted sutures, or with a "baseball" suture, or the edges may be made to overlap (fig. 4 [2]). Sundry suture materials have

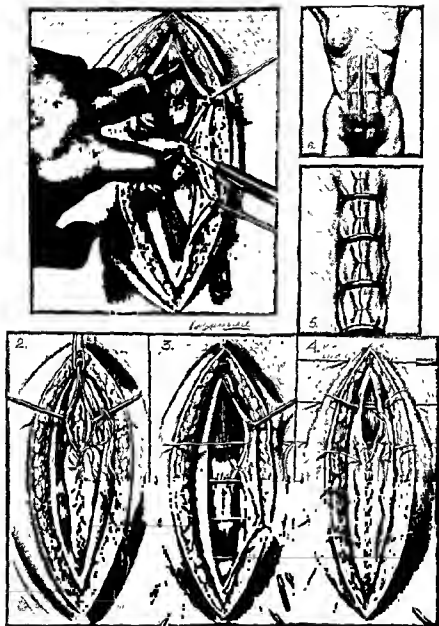


FIG. 4.—UPPER RIGHT PARAMEDIAN INCISION.

(1) Dissecting the rectus muscle at the linea transversa.

(2) The peritoneum and posterior sheath of the rectus muscle are being approximated by a continuous baseball suture.

(3) and (4). The process of suturing the anterior sheath of the rectus muscle.

also been used, these varying with the practice of the individual surgeon. For instance, some will use interrupted or continuous sutures of fine silk and others No. 1 or No. 2 plain catgut or No. 1 chromic catgut, the usual practice being to suture this important layer with No. 0 chromic catgut, used either as a single or a double strand, a few interrupted sutures also being inserted in order to relieve strain on the suture line.

After the peritoneum has been closed, the tension or stay sutures of silkworm gut are inserted through the skin at intervals of about 1 inch, picking up both edges of the anterior sheath of the rectus muscle. The ends of these sutures are clipped with haemostats after they have been threaded through small pieces of rubber tubing, but they are not tied until the anterior sheath of the rectus and the skin have been approximated (fig. 4 [5]). It is best to use interrupted sutures for closing the anterior aponeurosis, and here again the sutures may be introduced to make the edges of the aponeurosis overlap if this is deemed necessary. The fatty layers of the skin should be brought together with fine interrupted sutures, so inserted and tied that their knots lie in the depths of the wound facing the rectus sheath and not near the surface of the skin. The skin edges may be closed according to individual preference, a reliable method and one which yields pleasing results being the insertion of very fine silkworm gut or silk sutures, deknattel, etc., introduced as vertical mattress sutures and supplemented with Michel clips applied gently and evenly to ensure a neat approximation.

Lower Paramedian Incision. This incision is, of course, used for exploring the pelvic organs, the caecal region, and the lower reaches of the large intestine. It is by far the best sub-umbilical incision and is infinitely preferable to the midline incision which is so prone to be followed by ventral hernia and possibly by strangulation of the small gut.

As already stated, it is important to open the peritoneum at the upper end of the incision rather than at the lower end in order to avoid wounding the bladder. This incision is very speedily closed, but it should be remembered that as the posterior layer of the rectus sheath is absent below the semilunar fold of Douglas it is most important to include a little muscle when inserting the peritoneal stitches. A few supporting sutures of silkworm gut are passed through

the anterior sheath of the rectus to give added security, while the anterior sheath is closed with a series of interrupted cross stitches and the skin approximated in the usual manner. As this scar is very likely to stretch, the fatty layer should be stitched with the finest suture material.

2. **Transverse Abdominal Incisions.** These are excellent incisions, and are, in my opinion, all too infrequently employed. This is probably due to the fact that they entail considerably more time and care in planning and execution than do vertical ones. However, the exposure afforded by supra-umbilical transverse incisions is in many respects superior to that afforded by vertical ones in that they are easier to suture and are less likely to be followed by post-operative complications such as ventral hernia or a stretched scar. There are two main types: In the first, all the layers of the abdominal wall are cut across transversely in line with the incision. The rectus muscles may be sutured to their sheaths before they are divided, although some surgeons do not consider this to be an important step. In the second type, after the transverse skin incision has been made, the anterior aponeurotic sheath is separated from the underlying muscular mass in an upward and downward direction and the muscles are widely retracted outward, permitting transverse division of the posterior sheaths and of the peritoneum. Sanders rightly considers that by this conservation of the continuity of the muscle fibres the anatomical and physiological relations of the abdominal wall are not destroyed and its integrity is maintained. The main drawback to this incision is that it is not easy to separate the aponeurosis at the tendinous intersections without buttonholing or injuring the recti, although with care, patience and practice this difficulty can be overcome. It should, nevertheless, be remembered that the rectus muscle may be cut across transversely, but provided it is carefully sutured or rather that its aponeurotic sheath is accurately closed, no serious weakening of the abdominal muscles results, as such a cut passes between adjacent nerves without injuring them. The rectus muscle has a segmental nerve supply, so that there is no risk of a transverse incision depriving the distal part of the muscle of its nerve supply as there would be if a muscle were divided which depended upon a single nerve, e.g., a muscle of the leg. To those surgeons who have never previously employed the transverse incision it may seem to be cum-

bersome and awkward, and that much time is spent on opening and closing the abdomen. However, repetition of and familiarity with the procedure should overcome all such difficulties.

Sanders' Technique of the Transverse Epigastric Incision with Separation rather than Division of the Rectus Muscles. The skin incision is made transversely, to extend from one costal margin to the other, although when the costal angle is wide a shorter incision can be made according to the requirements of the operation. Again, the exact site of the incision is determined by the width of the costal angle; the wider the angle, the higher above the umbilicus the incision should be placed. In the average case the incision should cross at the junction of the middle and lower two-thirds of an imaginary line drawn between the xiphisternum and the umbilicus. In actual practice the incision usually crosses the midline at a point about two finger-breadths above the umbilicus.

After the skin incision has been made, the anterior sheaths of the rectus muscles are displayed, but the subcutaneous tissues are not dissected away from these sheaths in a longitudinal direction, at least not for any appreciable distance. The aponeurosis is then divided in line with its fibres, *i.e.*, transversely, and is separated in an upward and downward direction from the underlying muscles.

Since the recti are firmly adherent anteriorly to the sheaths, especially at the tendinous intersections, the sheaths must be raised carefully and dissected off the muscles with scissors for a distance of 2 or 3 inches upward and downward. During this dissection hæmorrhage occurring from the muscle may be tediously troublesome to control. Bleeding points should not, however, be picked up with hæmostats, but should rather be underrun with small round-bodied needles threaded with plain catgut and be gently tied. If they are too tightly ligated, the muscle fibres will be cut across; if they are grasped with hæmostats, the muscle is likely to be lacerated in the process of ligation and more troublesome bleeding will occur. The utmost caution must also be exercised in freeing the sheaths from the lineæ transversæ, otherwise the muscles may be weakened and their fibres be more easily torn by retraction. On the posterior aspect of the rectus muscles the sheaths can be freed quite simply, as adherence here is only minimal.

Both rectus muscles are then firmly retracted laterally, and the

posterior sheath and peritoneum are divided transversely in line with the original skin incision. While the peritoneum is being opened, the ligamentum teres should be clamped and divided between ligatures. Suitable retractors are now placed in position and the wound is opened wide for exploration (fig. 5 [3]). Drainage tubes are best brought out through the right side of the wound, lateral to the rectus muscle (fig. 5 [6]).

The wound is sutured in layers, starting from the left side. The peritoneum and posterior sheaths of the recti are adherent and are best approximated with a continuous suture of catgut, the divided ends of the ligamentum teres being brought together by including them in this suture. The rectus muscles now fall back into their normal position, and their anterior sheaths are closed by interrupted or continuous sutures. It will be seen that although the patient may be straining, there is no tension on the wound, and its edges can be approximated with the greatest ease. When the anterior sheath has been closed, three interrupted sutures of chromic catgut should be placed in the linea alba as an additional measure of safety. The wound edges are closed with Michel clips, interrupted sutures, or a combination of both, the final cosmetic results leaving very little to be desired.

Transverse Epigastric Incision with Division of the Rectus Muscles. This incision is placed just above the second or the third tendinous intersection, and passes transversely across the upper abdomen, reaching almost to the costal margin. But in cases in which an emergency laparotomy is indicated, a line one or two finger-breadths above the umbilicus is chosen. The incision is made through the skin and superficial fascia down to the sheaths of the rectus muscles at the level indicated, and the skin flaps are dissected away from the sheaths for about $\frac{1}{2}$ inch on either side so as to render the subsequent closure easier. The tendinous intersections are then identified and the sheaths of the recti are opened transversely about 1 inch above one of them. Both rectus muscles are next divided through their entire thickness down to the posterior sheaths, the peritoneum then being cut for the full length of the incision. The falciform ligament will need division and ligature, the ends then being dropped back into the abdomen. Some surgeons, however, stitch each rectus muscle with a series of interrupted sutures above and below the proposed line of

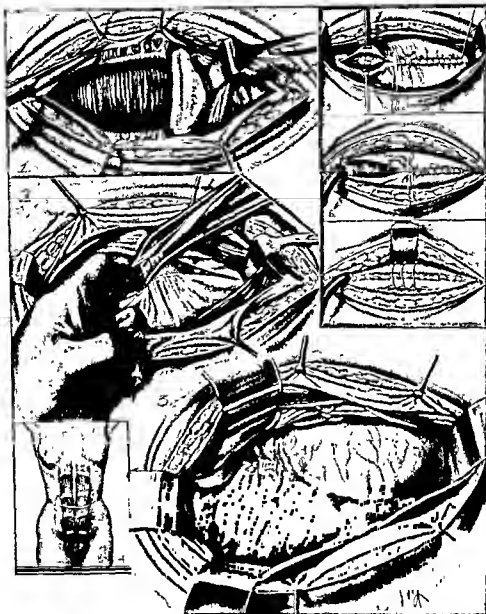


FIG. 5.—TRANSVERSE EPIGASTRIC INCISION WITHOUT DIVISION OF THE RECTUS MUSCLES—SANDERS' TECHNIQUE.

transection, and in order to do this efficiently and prevent injury to the underlying intestine, they open the peritoneal cavity by a small incision in the linea alba through which the left index finger is inserted (fig. 6 [1]). After lifting the rectus muscle forward, a series of

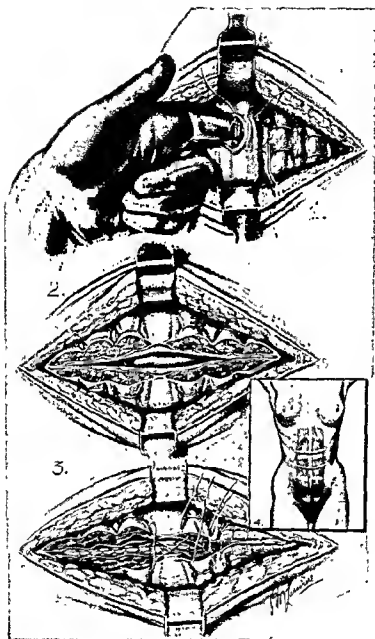


FIG. 6.—TRANSVERSE EPIGASTRIC INCISION WITH DIVISION OF THE RECTUS MUSCLES.

sutures are inserted, usually three above and three below the proposed line of section in each rectus, each suture passing through the anterior sheath and the entire thickness of the muscle, picking up a small bite of the posterior aponeurosis but not penetrating the peri-

toneum (fig. 6). The object of this is obvious; it prevents hæmorrhage and retraction of the muscle fibres after they are cut.

The wound is closed by stitching the peritoneum and posterior aponeurosis with a continuous suture, the ends of the falciform ligament being picked up while this layer is being approximated. As there is no tension there is no need to insert supporting sutures of silkworm gut, and the sutures that are inserted into the anterior sheaths of the rectus muscles do not cut out when applied, as they are inserted at right angles to the aponeurotic fibres. It is best to close the anterior sheaths with interrupted vertical mattress sutures of No. 1 chromic catgut, while the insertion of a figure-of-eight silk suture on the midpoint of the recti, securing all four points on the two sheaths, is considered by Lynn and Hull to be an important point in technique. This is well illustrated in figure 6 [3]. When drainage is required, the tubes are placed at one extremity of the incision.

Pfannenstiel's Incision. This incision may be used for certain gynecological operations such as ventro-suspension of the uterus, removal of a small solitary uterine fibroid or ovarian cyst, or for appendicectomy in women when it is desired to explore the pelvis in the absence of any clinical evidence of gross organic disease of the uterus or its adnexa.

This incision is usually about 5 inches long, and is placed in the curving interspinous crease, its central point being approximately 2 inches above the symphysis pubis. It is deepened, and the aponeurosis is exposed and divided for the whole length of the wound, *i.e.*, transversely. Hemostats are clipped to the upper and lower edges of the rectus sheath which is then widely separated above and below from the underlying rectus muscles. It is necessary to separate the aponeurosis in an upward direction almost to the umbilicus and downward to the pubic arch. The recti are then retracted laterally, and the peritoneum is opened vertically in the midline, care being taken not to injure the bladder at the lower end of the wound. When it is intended to employ this incision, it is advisable to catheterise the patient prior to operation, as a full bladder will lend itself to injury and will also limit the exposure of the pelvic organs. The exposure afforded is somewhat limited, but is nevertheless adequate for the purpose for which it is usually employed, especially if retraction is good (fig. 7).

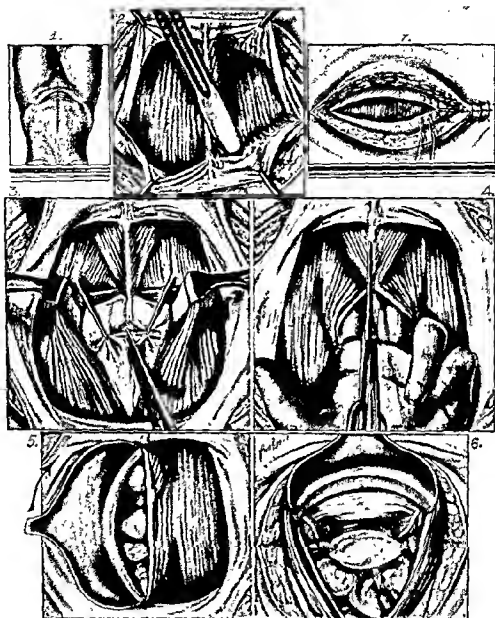


FIG. 7.—PTANNENSTIEL'S INTRA-UMBILICAL CURVED INCISION IN THE INTERSPINAL WRINKLE.

The details of making and closing the incision are depicted.

In those cases in which, after having dealt with some pelvic condition, it is desired to remove the appendix, but the cecum lies tethered far afield in the right iliac fossa and cannot be drawn into the wound, it is an easy matter to approach the appendix by firmly retracting the

belly of the right rectus muscle inward toward the middle line and cutting across the peritoneum and lateral abdominal muscles in line with the right outer portion of the curved incision. In this way no nerves are divided, but the inferior epigastric vessels will require ligation.

After dealing with the appendix, the outer portion of the wound is sutured in layers, the recti fall back into position, and after suturing the peritoneum the aponeurosis is approximated with a series of closely applied interrupted mattress sutures (fig. 7 [7]). The subcutaneous tissues and the skin are then brought together in the usual manner.

Pfannenstiel's incision leaves an imperceptible scar, as it is placed in one of the natural creases of the body, and subsequently the major part of the wound is hidden by pubic hair.

3. **Lateral Abdominal Incisions.** Of these there are three:

(a) Kocher's subcostal incision for exposure of the gall-bladder or spleen.

(b) *McBurney's incision* for exposure of the cæcum and appendix.

(c) *The oblique lateral incision* adopting McBurney's gridiron plan (Constantini and Marill), or the severance of all the lateral abdominal muscles in line with the incision as employed for operations upon the colon (Kocher).

Kocher's incision is used very frequently in surgery of the gall-bladder and biliary passages, and is the incision of choice for such cases in a large number of clinics. It would, however, seem to possess no distinct advantage over the right upper paramedian incision in patients who are thin or in those in whom the costal angle is very narrow; but in the opposite type of cases, i.e., obese patients and those in whom the costal angle is very wide, the subcostal incision cannot be bettered, although anatomically it can never be ideal, as muscles are divided and at least one important nerve—the eighth dorsal—is almost invariably severed. Nevertheless, when properly sutured, this wound unites firmly, the scar is neat, and the development of a ventral hernia is, in my experience, an exceptional sequel, even in cases in which prolonged drainage of the operative field has proved necessary.

A left subcostal incision is sometimes employed for splenectomy in obese patients, for some cases of splenic anæmia, and in carcinoma

involving the upper end of the stomach, although in the latter disease a left paramedian or Marwedel's incision with retraction of the costal margin is a better method of approach to the intraperitoneal portion of the œsophagus.

Kocher's subcostal incision commences exactly at the midline, about 1 to 2 inches below the xiphisternum, and extends for 5 inches downward and outward about 1 inch or so below the costal margin. It should not be extended as far round as the flank, or too many nerves will be severed. The rectus muscle should be completely divided, after which the lateral abdominal muscles are cut in an outward direction for a variable distance. This complete division of the rectus muscle, preferably between the upper and middle tendinous intersections, must be emphasised, as to leave some of the inner fibres of the muscle intact would restrict the surgeon's manipulations and thereby prevent adequate access to the gall-bladder and biliary passages. The nerves will be seen entering the rectus muscle at its outer border, and although the small eighth dorsal nerve will almost invariably be cut, the large ninth must be seen, dissected free for an inch or so, and drawn out of harm's way. Under no condition is it permissible to divide this large and important nerve.

The incision is very easily closed, using a continuous suture for the peritoneum and posterior rectus sheath, and at the same time picking up some of the lateral abdominal muscles. After a few supporting sutures of silkworm gut have been suitably placed, the edges of the anterior rectus sheath and the external oblique are brought together by a series of interrupted vertical mattress sutures of chromic catgut, and the skin edges are then approximated in the usual manner. Drainage tubes are made to emerge either at the medial end of the incision, i.e., near the midline, or at the lateral end, i.e., toward the flank, whichever seems best for the particular case.

McBurney's gridiron incision is the one of choice for appendicectomy in most cases of acute appendicitis, although in certain instances already indicated the right lower paramedian incision is preferable. McBurney's incision is also used for cæcostomy, appendicostomy, and occasionally for the establishment of a permanent ileostomy in cases of acute ulcerative colitis. The level and the length of the McBurney incision will vary according to the position of the appendix and the

thickness of the abdominal wall; but in a general way it is made at right angles to an imaginary line joining the anterior superior spine with the umbilicus, at the junction of the middle and outer thirds, one-third of the incision being above this line and two-thirds below,

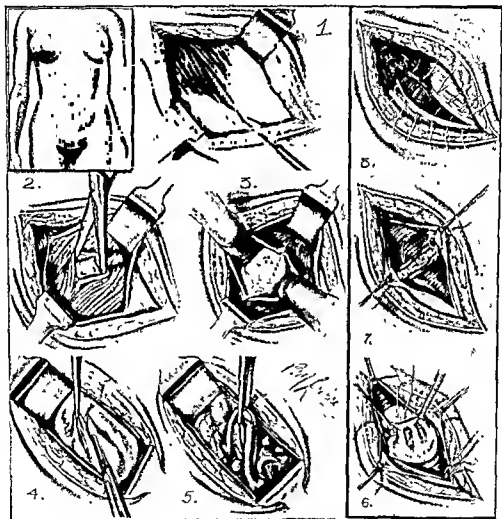


FIG. 8.—McBURNAY OR GRIDIRON INCISION, AS EMPLOYED FOR APPENDICECTOMY.

the main direction of the incision being downward and inward, conforming where possible to the natural creases of the abdominal wall (fig. 8).

In cases of acute appendicitis, when the patient is fully anæsthetised it is advisable to palpate the abdomen carefully in order to

determine as far as possible the exact position of the appendix so that the incision may be placed directly over the diseased organ. In certain cases, for instance in children where the diagnosis is unequivocal and in athletes where the minimum amount of damage to the abdominal wall is essential, the incision can be made very small—2 inches—(buttonhole incision) and transverse.

After the skin incision has been made, the external oblique aponeurosis is divided in the direction of its fibres, each edge being picked up with hæmostats and retracted widely, after which the internal oblique muscle will be seen with its fibres running transversely toward the outer border of the rectus (fig. 8 [1]). A small incision is then made in this muscle near the outer border of the rectus, and this is enlarged with the handle of the knife or the points of a pair of Mayo scissors, to permit the introduction of the two index fingers between the muscle fibres so that this muscle and the underlying transversus can be retracted with a minimal amount of damage (fig. 8 [3]). A fold of peritoneum is then picked up and nicked with a knife, after which this little incision is enlarged so that it can be fully stretched with the index fingers. This tends to produce a circular hole in the peritoneum which, at the completion of the operation, is easy to close with a purse-string suture (fig. 8 [6]). As the separated edge of the internal oblique and transversus tend to fall together, they need only be united with one or two sutures, but these should not be tied too tightly, as this would lead to strangulation of the muscle and an excessive outpouring of serum. The aponeurosis is stitched with interrupted sutures and the skin is closed as already described, although at times it may be advisable to insert a subcuticular stitch in order to attain a perfect cosmetic result which is so satisfying.

If during the course of the operation the appendix is found to be somewhat inaccessible, this wound can be very easily enlarged by employing the Fowler-Weir extension whereby the anterior sheath of the rectus muscle is divided in line with the incision and the belly of the rectus retracted inward, after which the opening in the peritoneum can be suitably widened to afford the necessary access. This will provide excellent exposure, not only of the whole cæcal region and of the lower coils of the ileum but also of the uterus and its adnexa. If in cases of peritonitis it is deemed inadvisable to use

this extension on account of widespread suppuration which may later involve the posterior sheath of the rectus, it is an easy matter to detach the internal oblique and transversus muscles from the outer border of the rectus, either in an upward or downward direction, the former being preferable. If the inferior epigastric vessels are encountered in the downward prolongation of the incision, they should be clipped in two places and divided, and the ends securely ligated. If the muscles which have been cut are carefully sutured in place at the completion of the operation, no harm will result from their severance.

In a small proportion of cases, which has so far not been accurately assessed, inguinal hernia is found to follow the use of the gridiron incision. A consideration of the anatomy of this incision explains this unfortunate complication. The ilio-hypogastric and ilio-inguinal nerves play a large part in supplying those portions of the internal oblique and transverse muscles which constitute the conjoined tendon. This muscle mass is certainly a most important constituent of the inguinal canal and is responsible for the "shutter-action" whereby the muscle descends, protecting the posterior wall of the canal during straining, coughing, etc. If these nerves are injured, this important muscle will atrophy, predisposing to the development of an inguinal hernia. The ilio-hypogastric and ilio-inguinal nerves lie between the internal oblique and the transversus abdominis at the site of the gridiron incision, and when the wound is enlarged may be damaged by too firm retraction, by strangulation with sutures, or, in septic cases, by constriction due to scar tissue. The division of the ilio-inguinal nerve during operations for inguinal hernia produces no ill-results, as the nerve is entirely sensory by the time it reaches the inguinal canal.

Lateral Oblique Abdominal Incisions for Exposure of the Colon, Adopting the McBurney Method. In order to obtain the maximum degree of exposure of the colon when employing this incision, the position of the patient upon the operating table is of some importance. It is well to employ a slight Trendelenburg position and to prop up one buttock with a sandbag so as to raise the affected side and cause the coils of small intestine to fall away from the operative field.

Constantini and Marill (*Rev. de chir.*, 3:498, 1934) have adapted

McBurney's principle with the Fowler-Weir extension for exposing tumours of the colon, and this incision is also favoured by Sebrechts of Bruges. The incision starts at the tip of the tenth rib and curves downward and inward, reaching the midline about 3 inches above the pubis. The external oblique muscle is split in the direction of its fibres, i.e., in the direction of the wound, and the internal oblique and transverse muscles are likewise severed in the direction of their fibres, forward and inward. The anterior sheath of the rectus is divided in line with the division of the two latter muscles, and the rectus muscle is then firmly retracted inward. After drawing apart the lateral abdominal muscles, an extensive incision is made in the peritoneum in line with the original incision in the skin. This incision affords excellent exposure, no nerves are injured, it is very simple to suture, and post-operative hernia is practically unknown. This being the case, it is frequently employed for cases of cancer of the colon which involve the right or left portion of the large intestine.

Lateral Oblique Abdominal Incision with Division of all the Muscles in the same Direction as the Skin Incision. This incision was first used by Kocher and has been favoured by Stiles, Rutherford Morison, Grey Turner, Lanz and other surgeons for certain cases of acute appendicitis, especially when the appendix is lying in a retro-cæcal or retro-colic position or when there is considerable surrounding induration and matting, suggesting that drainage may be required, and also for operations upon the ascending or descending colon.

The incision is placed as nearly as possible over the diseased organ, and the external oblique, the internal oblique and the transverse muscles are divided in line with the skin incision, the peritoneum also being divided in the same direction (fig. 9). When this incision is accurately sutured, ventral hernia is a rare occurrence, as Grey Turner has emphasised. It gives excellent exposure and, as it is not valvular, it permits of free drainage; furthermore, as it gives direct access to the appendix, the coils of small gut are not exposed to the danger of contamination. When employed for cases of cancer of the colon it should, of course, be longer and should start from the tip of the tenth rib and proceed obliquely downward and inward toward the upper portion of the pubes. The various layers of the

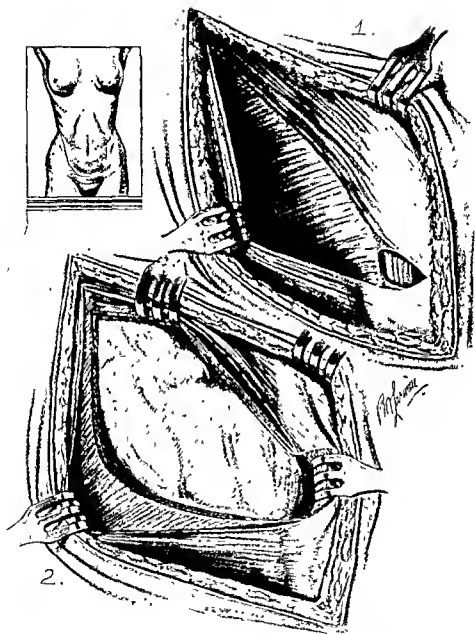


FIG. 9—KOCHER'S LATERAL OBLIQUE INCISION, SOMETIMES EMPLOYED FOR EXPLORING THE ASCENDING COLON IN CASES OF CARCINOMA.

abdominal wall are divided *seriatim* in a line with the original incision, although at the lower end of the wound the rectus muscle instead of being divided may be retracted inward after the method suggested by Weir. The exposure thus obtained is good, and provided the individual layers of the abdominal wall are carefully approximated the resulting scar will be excellent in every respect.

CHAPTER 2

MANAGEMENT OF THE WOUND

The management of the wound is best discussed under separate headings, as follows:

1. In *clean* cases.

2. Where there are *complications* such as: (*a*) hæmatoma; (*b*) infection; (*c*) disruption; (*d*) keloid; (*e*) post-operative progressive bacterial synergistic gangrene; or (*f*) post-operative ventral hernia (see pages 48-64, 1011).

Clean Cases. The dressings that have been applied to the wound in so-called "clean" cases which have been sutured under ideal sterile conditions should not, as a rule, be disturbed until the skin sutures are due to be removed. The following circumstances would, however, call for an earlier inspection of the wound: (*a*) where there are signs of infection; (*b*) where the dressings have been displaced; (*c*) where there is soiling of the dressings with blood or serum; (*d*) where drains have been inserted, either into the abdominal cavity or between the various layers of the wound to give vent to the oozing of blood or serum.

Infection of the wound, however trivial, occurring in a series of clean cases, should always be a matter of concern and is frequently a reflection upon the technique employed by the surgeon. It calls for a complete revision of the methods which have been adopted by the surgeon or his personnel in the operating room or his management of the wound in the post-operative period. A study of the temperature chart is a most valuable guide to the state of the wound. After an aseptic operation there is frequently, although not invariably, a slight rise in temperature (between 99° and 100° F.) during the first two days. By the end of the third day the temperature should fall to normal and remain so. Continuance of the temperature or a rise after a temporary fall would suggest that the wound has become infected, calling for removal of the dressings. If the dressings become displaced or blood-stained, the wound should be promptly re-dressed

and thereafter inspected daily for the next two or three days to make sure that progress is satisfactory. In aseptic cases in which drains have been inserted, either into the abdominal cavity or between the various layers of the abdominal wall, it is best in many instances to remove the dressings and withdraw the drains at the end of forty-eight hours. These wounds will also require daily dressing until the skin sutures are removed; they should, in fact, always be suspect until they are firmly healed.

At the completion of an abdominal operation most wounds are painted with the antiseptic solution which was used in preparing the abdominal field, and after applying a generous quantity of gauze to the area this is strapped into position by means of adhesive strips. When the wound is re-dressed it is best to cut the plaster strips at the margins of the gauze pad, to conduct the necessary toilet of the wound, and to fix the new dressings in position with fresh strips of plaster which are applied to the strips which have been left in situ. Later, when the wound is nearly healed, the plaster strips can be easily removed by using ether, benzine, or one of the recognised commercial adhesive softeners such as antihæsin. This is better than continually stripping off and re-applying fresh plaster strips at each dressing—always a painful procedure.

Superficial interrupted skin sutures of silk, silkworm gut or horse-hair are as a rule removed between the fourth and the seventh days, while continuous sutures are allowed to remain a day or two longer. If Michel or Kifa clips have been used to approximate the skin edges, the majority of these should be removed on the second or third day, and the remainder on subsequent days. Subcuticular sutures should not be withdrawn too early; they are best left in position for seven or eight days, while tension or supporting sutures are removed on the twelfth day. Through-and-through wire sutures are withdrawn between the twelfth and eighteenth post-operative days.

Should there be any gaping at the edges of the wound after extraction of the sutures, it is wise to place small strips of flamed adhesive plaster across the wound at intervals to hold the edges together.

No hard and fast rules with regard to the *time for removal of drainage tubes* can be laid down, as this will, of necessity, vary with the purpose for which they have been inserted. But in a general way it may be stated that drains which have been introduced to give vent

to oozing of blood or serum should be withdrawn at the end of twenty-four to forty-eight hours. Again, in cases of general peritonitis or where there is gross contamination of the abdominal cavity during operation, the drains which have been inserted should not be allowed to remain in situ for more than two days; but where a localised abscess, *e.g.*, appendix abscess, has been drained, the tube or tubes will have to remain in position for a longer period. After a few days they should be rotated and shortened, until eventually they are replaced by tubes of smaller calibre. In cases of cholecystectomy a drain is usually inserted in the region of the liver bed to allow of the escape of serum or possibly bile. Such tubes should be withdrawn on the second day following operation since after this time they fulfil no useful purpose.

When dealing with the various operations in which drainage is called for, an attempt will be made to indicate to the surgeon where the tubes should be placed and for how long they should remain in position.

WOUND COMPLICATIONS

Hæmatoma. The incidence of hæmatoma occurring in clean operative wounds varies from about 5 to 15 per cent, *i.e.*, in about the same proportion as infection occurs in clean cases. Meleney has shown that at the Presbyterian Hospital, New York, in 1929 there were 771 operations, in 141 of which (18 per cent) hæmatomata formed, whereas in 1933 there were 1,132 cases, in which 62 (5.5 per cent) developed. He attributes this lowered incidence to the adoption of the silk technique by the surgical staff of that hospital.

Hæmatomata are, of course, due to faulty hæmostasis of the layers of the abdominal wall, but are not serious unless they become infected. They usually give rise to an aching pain in the wound, which is accompanied by a slight rise in temperature. Small hæmatomata may be difficult to detect, but on careful palpation they may be felt as small hard rounded areas, usually underneath the line of the skin incision. When they are near the surface they may produce a brown or mauve-coloured blister which is tender, soft and fluctuating. As these small hæmatomata usually resolve, they may be left alone. If large, and particularly if soft, they should be aspirated with a wide-bore needle, or the edges of the wound which overlies them should be

separated with a probe or a sharp-pointed scalpel and the contents evacuated. A small rubber drain should then be inserted into the cavity to prevent a reaccumulation of serum and to facilitate the process of healing. If there is a large extravasation of blood in the wound, giving rise to ecchymoses of the skin and a fluctuating mass, it is best to return the patient to the operating theatre and open up the wound, evacuating the clot and ligating any bleeding vessels that are visible, after which the wound should be partly closed and drainage provided.

Infected Abdominal Wounds. Every abdominal wound becomes contaminated at the time of operation, but happily only relatively few become infected. An infected wound is not necessarily one in which there is perceptible pus; in fact, in some early virulent streptococcal infections the wound may appear to be progressing favourably in spite of a raised temperature and constitutional symptoms associated with pyrexia. All degrees of infection may be seen, from the localised pale red blush of cellulitis around one or two stitch holes, to a wound that is tensely swollen, crepitant, discoloured with the tinge of death, and discharging—perhaps at only one point—from its necrotic filthy depths an evil-smelling, viscid, frothy, mud-coloured substance laden with gas bacilli.

What percentage of clean cases becomes infected? I should like to think with Meleney that it is only in the region of 5 per cent, and that an irreducible minimum has been reached; but MacFarlane reports 7 per cent, Thorek 7.17 per cent, McKim 8 per cent, Carraway 10 per cent, Goff 12.1 per cent, Coley 12.8 per cent, and Roberts and Roberts 12.8 per cent. A fair assessment is therefore in the region of about 10 per cent. Mere personal impressions are usually grossly inaccurate, and when a surgeon states that the number of wound infections in his clinic is negligible the statement should be discounted until an accurate count and close study of the case sheets have been made. Meleney, as the result of some very careful investigations, has shown that at the Presbyterian Hospital the incidence of infection in clean operative wounds was 14 per cent for 1925, but that by rigid attention to all possible sources of infection and by the application of improved methods for its prevention, this figure was reduced to 4.8 per cent by the end of 1933.

The chief causes of wound contamination and some of the more

important prophylactic measures advised may be discussed under the following headings:

(a) The skin of the patient.

(b) The nose and throat of each individual in the operating theatre.

(c) The hands of the operating personnel.

(d) The air of the operating room.

(e) The instruments and materials used at operation.

(f) The operative technique.

(a) *The Skin of the Patient.* The surface of the skin abounds with organisms, and these can either be washed away or destroyed by means of appropriate disinfectants. Organisms in the deep glands and ducts of the skin cannot be adequately dealt with by any antiseptic yet discovered. Nevertheless, every effort should be made to render the surface of the skin sterile, and special approved disinfectants should be employed to ensure deep penetration of the skin without causing damage. Prior to any abdominal operation, whatever its nature, the skin preparation should include the whole area of the abdominal wall and at least the lower half of the chest and the upper half of the thighs, as well as the flanks. The following method of preparation has proved satisfactory: Gauze-sponge swabbing with ether followed by painting with tincture of iodine which is washed away with alcohol after it has been allowed to dry on the skin.

The knife which is used to make the skin incision should be discarded and a fresh one employed for completing the dissection. The frequency with which the scalpel may carry organisms from the surface of the skin into the deeper layers of the wound has been referred to by several surgeons including Thorek, Cox, Sutton, Van Alstyne and Carraway. This last-named author is quoted by Eliason and McLaughlin as having cultured a series of 562 blades used in making the primary skin incisions and as having found that of them 117 (20 per cent) yielded a positive culture.

The bacteria lurking in the deep ducts and glands may again become of some importance during the stage of sewing up the skin. If that most unsuitable of all skin sutures—a continuous suture—is used, the needle may gather up bacteria and distribute them all along the suture line. The likelihood of such contamination may be mitigated

by using individual interrupted sutures carried on separate needles.

The skin should be prevented from coming into contact with gloved hands, with the wound itself, or with the abdominal viscera by carefully affixing to the edges of the wound tetracloths or suitable towels which are maintained in position until the closure of the wound is almost complete. Thin handkerchiefs or flimsy strips of gauze which serve no useful purpose are often used as tetracloths, a practice which should certainly be abolished. The use of hot wet towels instead of dry tetracloths for isolating the abdominal wound is an often-unrealised source of infection. These hot wet towels cause a great deal of sweating and this sweat which is always infective may be carried into the wound and light up a septic process. Another disadvantage of these wet towels is that they quickly lose their warmth and, becoming cold and clammy, lead to chilling of the skin and thus to pulmonary complications.

Any laxity in the aseptic ritual connected with the post-operative dressing of abdominal wounds will predispose to wound infection. Precautions must therefore be rigid. The wash-up should occupy a full ten minutes, and sterile gloves should be donned as for operation. After arranging sterile towels around the abdomen, the wound should receive appropriate treatment. All too often the handages and the dressings are removed with ungloved fingers, and sterile dressings are applied with unsterile hands.

(b) *The Nose and Throat of each Individual in the Operating Theatre.* Meleney and Stevens (*Surg., Gynec. & Obst.*, 43:338, 1926) were among the first investigators to call attention to the role played by streptococcal carriers in the production of wound infections. In investigating a series of streptococcal infections developing shortly after operation, these authors found that 30 per cent of the operating room team were harbouring hæmolytic streptococci in their noses. Meleney, from a study of the bacterial content of the air in his operating room, has established that between 35,000 and 60,000 bacteria fall upon the sterile operative field during the course of one hour, and these observations have been confirmed by Staige Davis, Hart, Truesdale, Hunt, Gudin and Brewer. From this it is obvious that adequate masking of both the noses and mouths of all the operating room personnel would greatly limit this source of contamination of the operative wound. The ideal mask has not yet been discovered,

although numerous modifications of the ordinary gauze mask have been given a trial. For instance, some surgeons have incorporated an impervious material such as thin rubber or cellophane into the mask to increase its effectiveness; but these are very hot and uncomfortable and do not reduce droplet contamination from the nose and mouth. A good serviceable mask is one made of fine mesh 4-ply gauze, which should cover the nose, the mouth, the chin and the sides of the face. In many hospitals one still sees surgeons operating without a mask, with one which is thin and flimsy, or with one which does not cover the nose. The cap and mask should be donned after a preliminary scrub-up, and not, as is so frequently done, after sterile gowns and gloves have been put on, and the entire operating-room personnel should be similarly attired. These rules should apply also to all visitors admitted to the floor of the operating room.

Wound infections occur much more frequently during epidemics of respiratory diseases, as the number of streptococcic carriers is then greatly increased, and at such times extra precautions, such as the use of two masks, etc., should therefore be enforced. The surgeon who has a cold should preferably not operate, but if obliged to do so he should double the time taken in scrubbing up and in treating his hands antiseptically before operating and should also wear two masks.

(c) *The Hands of the Operating Personnel.* Normally the hands are covered with organisms, while virulent organisms are often picked up in the creases of the hands when attending to the patients' dressings or even in handling the bedclothes. The scrub-up should therefore be thorough and methodical. The hands of each surgeon and nurse engaged in the operation should be vigorously scrubbed under running warm water, using liquid green soap, as during this process countless organisms will be removed from the surface of the skin and from the crevices of the hands. The wash-up should be timed to occupy not less than ten minutes, after which the hands should be soaked or washed in eusol and then in alcohol. The antiseptic effect of the eusol and alcohol depends upon their close contact with the bacteria and the duration of this contact. To preserve the sterility of the gloves a sterile nurse should hand them open to the surgeon so that he may insert his hands without touching their exterior. If gloves are torn or punctured during operation—and it is

surprising with what frequency this occurs—they should at once be exchanged for fresh sterile ones, as the interior of the gloves soon becomes contaminated with the sweat of the hands. In all cases where an infected viscus has been excised, where any intestinal anastomosis has been undertaken, or where the gloves have become contaminated by infectious material during the conduct of the operation, they should again be changed.

(d) *The Air of the Operating Room.* The air of the operating theatre has been proved to contain many more organisms when the room is in use than when it is empty. Such factors as a crowded theatre (a most undesirable state of affairs at all times), the constant coming and going of assistants and visitors, the opening and closing of doors, the adjustment of blankets, the whispering and talking which take place, all conspire to increase the number of organisms present in the air and to disseminate them. It is often found that after demonstrations of operations before crowded galleries there is an increased tendency to wound infection. It is obvious therefore that the number of organisms can be reduced by eliminating currents of air within the room, by removing all objects which collect dust, by having balconies for onlookers, by restricting the number of visitors to the operating floor, by prohibiting unnecessary conversation—even whispering, and by keeping a constant watch that each onlooker is adequately masked and is attired in the approved style. Street shoes should be covered, and gowns should be securely tied at the back to prevent the hands from being thrust into the trouser pockets. Canopies should be placed over the instrument tables to cut down the air contamination, the walls and floors should be frequently washed with germicides, and the air should be filtered at regular intervals. During recent years many attempts have been made to sterilise the air in the operating room, and Gardner and Hart (*Surg.*, 1:458, 1937) consider that this is the most logical solution to the problem of air-borne wound contamination, but the methods adopted for this purpose have been laborious, cumbersome, and not without some degree of danger to those employed in the operating theatre. For instance, Gudin (*Presse méd.*, 44:355, 1936) attempted to sterilise the air in his operating theatres with formaldehyde. The operating room was sealed off and formaldehyde was blown into the room, after which the formaldehyde was neutralised with ammonia.

After a while the air was filtered through a solution of tartaric acid which removes the product of the combination of formaldehyde and ammonia, namely, urotropin, and also the gases of ammonia. The surgeon, his assistants, the nurses, the visitors and the patient are then made to pass through two airtight sterilised compartments before entering the operating room. Gudin states that as a result of these measures a very marked reduction in infection of clean operative wounds was immediately manifest.

It is very doubtful, however, whether this method will ever be widely adopted, since it is obvious that the theatre soon becomes re-infected with organisms from the air owing to the inadequate methods of masking which now prevail. Hart (*J. Thoracic Surg.*, 6:45, 1936), admitting that the ideal surgical mask has not yet been devised, considers that the use of radiant energy is the most logical method of continuous sterilisation of the air in the theatre. The radiant energy comes from a battery of tubes suspended over the operating table producing radiations in the ultra-violet spectrum of the most effective bactericidal wave-lengths. This ultra-violet radiation is used constantly both before and during the operation, the eyes and skin of the entire operating-room staff and of the patient being safeguarded against its effect. Experimentally, Hart found that the vast majority of organisms, especially those of the hæmolytic *Staphylococcus aureus* group, were destroyed after a very short exposure, and that in a large series of cases in which this method of radiation was employed none of the wounds became infected and rapid healing took place, there being a much quicker return to the pre-operative general condition.

Although there is no doubt that the air can be sufficiently sterilised by such means, precautions taken to prevent the patient and the operating personnel from sustaining burns and other forms of damage must always be adequate. This may sound simple in theory, but in actual practice it entails conditions which are complicated, exacting, uncomfortable and expensive, and it is therefore doubtful whether this method will ever find general acceptance.

(e) *The Instruments and Materials used at Operation.* These are, of course, well-known sources of wound contamination. Although towels, swabs and so forth can be very efficiently sterilised by autoclaving, and the usual instruments employed at operation, such as

forceps, retractors, etc., can be adequately sterilised by boiling for ten minutes, great difficulty has always been experienced in the sterilisation of sharp instruments such as knives, blades, needles and scissors, as well as of syringes and catgut tubes. A safe method is to soak these articles in pure carbolic acid for ten minutes, rinsing them in sterile water and then transferring them to a receptacle containing surgical spirit to which 10 per cent phenol has been added. Silk should be boiled for an hour and then be kept in alcohol. It is sometimes not realised that catgut itself is a source of wound infection. It is dead tissue, it must be digested, and in this process of digestion it becomes converted into a glutinous material which, in itself, is a favourable nidus for the germination of bacteria.

(f) *Operative Technique.* Excessive trauma and rough handling, such as merciless, relentless stretching of the layers of the abdominal wall by means of metal retractors, or the grasping and fraying of friable muscles by tissue forceps and large-toothed hæmostats, are not only evidences of bad surgical technique but tend to decrease the local resistance of the tissues to infection. The leaving of dead spaces in the wound after suture, the permitting of free extravasation of blood among the tissue spaces, the mass ligation of tissues, tension upon or strangulation of tissues by sutures, the use of thick suture or ligature material, and swabbing the wound with irritating chemicals are all factors which may contribute to poor wound healing and local complications. The need for gentleness would apply with equal force to suture of the abdominal wound. Every effort must be made during the operation to protect the wound from being contaminated with infected peritoneal exudates, from intestinal contents, and from coming into contact with diseased viscera, by methodical packing off with gauze swabs, mackintosh or cellophane squares, Cripps' pads and the like. This method of packing off the wound and the viscera will be described in greater detail when dealing with the individual operations.

Treatment. *Stitch Abscesses.* These are usually seen about the tenth post-operative day, but may occur earlier than this before any of the stitches have been removed or even some days or weeks after the wound has apparently healed quite soundly. Stitch abscesses may be superficial or deep. When deep they may be felt as rounded indurated masses in the depths of the wound, and are painful to the

touch. When superficial they may appear as brown or mauve-coloured fluctuating circumscribed blisters more or less in line with the incision. They produce a certain amount of uneasiness and pain in the wound, and although some of the more deeply situated ones may become absorbed and disappear, the superficial ones are best evacuated by incising the blistered area and squeezing out the contents which very often include a thick knot of catgut or silk with some blood-stained pus. The little sinus which remains may be lightly curetted out and packed with gauze which has been soaked in an aqueous solution of mercurochrome. Such sinuses heal rapidly as soon as the offending stitch is removed, leaving only a slight scar.

Cellulitis. In cases of cellulitis of the wound the appearances are usually quite typical. As a result of the surrounding inflammatory œdema the stitches appear to be buried deeply in the skin, the edges of the wound are covered here and there with inspissated pus or blood, there may be some oozing of serum between the sutures, and a faint red blush will be discernible in the region of the line of incision or stitch holes extending outward for a variable distance. The *Streptococcus aureus* may occasionally be responsible. The condition becomes evident a few days after operation and is generally associated with raised temperature and mild constitutional symptoms such as headache, anorexia and malaise.

By removing a few alternate stitches and applying hot wet compresses frequently, after adequately protecting the surrounding skin with some ointment such as equal parts of zinc oxide and castor oil, these wounds can in most cases be induced to heal without further complications. However, at times a localised abscess may form or suppuration may be extensive and involve some of the deeper layers of the abdominal wall.

Where there is a large collection of blood under the skin or where there is much fat in the abdominal wall which has become infected during the process of operation, infection with *B. coli communis* is very prone to occur with the formation of an extensive abscess. Such wounds have a dusky mottled appearance, being boggy and tender, this tenderness rendering it impossible at times to elicit the signs of fluctuation; but the appearance should guide the surgeon to remove a stitch or two and to probe the depths of the wound for deep-seated pus, which, when located, is often found to be brown, oily and foul-

smelling, and being under great pressure will rush from the depths of the wound with considerable force and soon flood the surrounding area. In such cases it is best to open up the wound in part and to irrigate it with hydrogen peroxide or a 2 per cent solution of mercurochrome, and to institute drainage. Prior to drainage, however, much serious damage may have been inflicted upon the muscles and their sheaths and upon other structures. Considerable necrosis may also have occurred, and if this involves a large blood vessel in the abdominal wall there may be signs of copious hæmorrhage which even packing or firm compression of the wound may fail to control effectively. These cases of secondary hæmorrhage due to suppurative myositis are best dealt with by completely opening up the superficial portion of the wound under a general or spinal anæsthetic, and after locating the bleeding area applying ligatures a short distance above and below the oozing surface in the muscle. This is no light task, for, the tissues being cheesy with inflammation, the sutures will readily cut out when applied, and the vessels responsible for the hæmorrhage may almost defy detection and isolation. When proximal and distal ligature of the responsible vessels proves impossible, a fresh incision will have to be made in healthy tissue to permit of isolation and ligature of the artery which is deemed to be the primary cause of the hæmorrhage.

When bleeding has been controlled, the wound should be packed with gauze soaked in hydrogen peroxide and the major portion left unsutured to permit of re-packing, frequent irrigation, and subsequent healing by granulation tissue.

In cases of mild generalised infection of the wound it may not be necessary to remove all the skin sutures, a few being allowed to remain, between which tubes are inserted into the depths of the wound for the purpose of drainage and irrigation (Carrel-Dakin method). Frequent hot wet dressings should be applied to such wounds, and the heat of the fomentations maintained by applying jaconet or rubber sheeting underneath the bandages.

In cases where it is found that the infection of the wound is due to streptococci, sulphanilamide should be given orally, as this has been found to be an effective method of medication.

Gas Gangrene Infection. It is surprising that gas gangrene infection of abdominal wounds is so rare when it is realised how often such

wounds become contaminated with septic peritoneal fluids and even with intestinal contents. Yet Orr (*J. Am. M. Ass.*, 102:2081, 1934) could only collect twenty-one cases from the literature, although the incidence must undoubtedly be very much higher than this figure would suggest. The infection is ushered in by severe pain in the wound, usually twelve to fourteen hours after operation, being associated with a high temperature (103° to 105° F.), rapid pulse rate (120 to 140), great prostration and a feeling of apprehension. The patient is gravely ill from the start, and lapses very rapidly into a muttering delirium.

When such wounds are examined in the early stages, the edges are found to be red and acutely inflamed, while later they become dusky, dark brown, and finally black from putrefaction. In some cases the reddened area round the skin incision takes on the yellowish-brown or bronze tint which is so characteristic of this infection. The wound is crepitant and discharges malodorous blood-stained pus containing gas bubbles.

The diagnosis is confirmed by culturing the sanguino-purulent exudate, when the large Gram-positive bacilli will be found. As soon as the condition is recognised, large doses of anti-gas gangrene serum should be given intravenously every eight hours. The ideal treatment—free excision of the wound—is here often impossible owing to the rapid spread of the infection and the position of the wound itself. The wound should nevertheless be widely opened up, freely drained, and irrigated with hydrogen peroxide or Carrel-Dakin solution. Recently, favourable results have been reported following the use of deep X-ray therapy and sulphathiazole. The prognosis is always extremely grave and very few patients will survive the onslaught.

Disruption of Abdominal Wounds. Disruption of abdominal wounds has been discussed under various titles, such as separation of abdominal wounds, broken-down abdominal incisions, post-operative rupture of abdominal wounds, post-operative evisceration, prolapse of intestine, post-operative eventration, and burst abdomen. The title here adopted would appear to be the one most generally accepted.

Disruption of the abdominal wound may be partial or complete. It is *partial* when one or more layers have separated, but either the skin or the peritoneum remains intact. When *complete* all the

layers of the abdominal wall have burst apart—dehiscence, and this may or may not be associated with protrusion of the viscera—evisceration. Again, the dehiscence, that is, the post-operative dissolution in the continuity of *all* the layers of the tissues involved in the operative repair of the wound in the anterior abdominal wall, may be partial (when only a portion of the wound is involved) or complete (when the whole length of the wound gapes).

Burst abdomen is a grave and tragic complication which may follow any abdominal operation in either sex at any age, and when it occurs it presents many serious problems in the management of the case.

Incidence. Estimates of the incidence vary between 0.3 per cent and 3 per cent, and it would seem well nigh impossible, as I shall attempt to show from published statistics, to say with precision what the true incidence really is.

The statistics relating to incidence err, for it has been noted that in the contributions of some writers only the wounds that gape or from which viscera protrude are so classified. Thus, if this report were to deal only with gaping disrupted wounds my series of 20 cases would be reduced to 13, and if only the cases of evisceration were presented the number would shrink to 3. In presenting this study I have included all cases in which a partial or an entire separation of the abdominal wound from the skin through the peritoneum occurred. It was thought that only in this way could a fair analysis be made, despite the apparent increase in frequency.

A further fallacy of statistics per se is demonstrable. Based on a study of 1,500 consecutive laparotomies, the incidence of disruption is 1.28%. It so happened that 6 dehiscences occurred in the last sixteen days of the eighteen-month period. If the study excluded these disruptions the incidence for 1,500 cases would be 0.93%. Again, if one were to consider only the cases of actual evisceration, of which there were but 3, the frequency would be 0.19%.¹

Sokolov (*Vestnik. Khir.*, 2:219, 1931) reported the largest group of cases on record, numbering 730, based on the experience of 187 European surgeons, and computed the incidence of burst abdomen as being between 1.5 per cent and 3 per cent. At a meeting of the New York Society in November 1933 there was an excellent symposium on disruption of abdominal wounds, and papers were read by members of the surgical staff of five large hospitals. In all, 175 cases were analysed and an attempt was made to assess the relative

¹ Milbert, *Arch. Surg.*, 31:86, 1935.

importance of the various ætiological factors concerned in the production of burst abdomen and also to decide upon the best form of treatment for such an accident (*Ann. Surg.*, 99:5, 1934). Meleney and Howes collected fifty-five cases over an eight-year period and showed that the incidence at their hospital was about 1 per cent. They considered, however, that this figure was probably inaccurate and that not every instance of the complication had been recorded owing to the fact that many cases upon which strapping of the wound was employed were not included in the case sheets, and that about 2 per cent would more nearly represent the incidence of this catastrophe.

Death-Rate. The death-rate, like the incidence, seems to me to be another point upon which considerable variance of opinion exists, the reported figures differing very widely. For instance, Horner (*J. Am. M. Ass.*, 93:126, 1929) quotes the mortality in four German clinics following gynaecological operations as follows: Sherer 75 per cent in a series of 4 cases; Holtermann 47 per cent in 15 cases; Madelung 22.3 per cent, and Erhardt 20 per cent. Meleney and Howes have reported a mortality of 44 per cent in 50 cases; Grace 39 per cent in 46 cases; White 53 per cent in 30 cases; Heyd 25 per cent in 4 cases; Colp 28 per cent in 26 cases; Maes 26.25 per cent in 44 cases; and Fallis 34 per cent in 49 cases. In Sokolov's large series the death-rate was 32.1 per cent. If a number of cases was carefully analysed it would be found that although many patients would eventually have died from the primary disease for which the operation was performed, even had the complication not occurred, the disruption actually precipitated the fatal issue.

Age. The age of the patient does not seem to have any bearing on the condition. I have known it to occur in an infant of fourteen days following a Ramstedt's operation for infantile pyloric stenosis, and in a woman of eighty-nine who had had a cholecystostomy. In Fallis's series (*Surg.*, 1:523, 1937) the ages ranged from fourteen to seventy-two years, the average being forty-three years. Over 75 per cent of his patients were in the fourth, fifth, or sixth decade, *i.e.*, in that period of life when individuals are most likely to be subjected to operations.

Sex. It is very doubtful whether sex plays any important part, although Sokolov reported that dehiscence occurred twice as frequently

in men as in women. In Colp's series the ratio was 7:5, in McIneney's and Howes's 2:1. In Fallis's series 27 cases were males and 22 females, while in Maes's series 24 were males and 23 females.

Type of Anæsthesia. It would seem obvious that the type of anæsthetic per se employed for the operation plays an insignificant and unimportant part, as it has been established beyond dispute that disruption occurs with equal frequency after local, spinal and inhalation anæsthetics, and specific reports as well as a study of many cases seem to bear out this point. It is, nevertheless, true that a badly administered inhalation anæsthetic associated with straining and struggling of the patient, entailing, as it does, hasty, forcible and perhaps inaccurate suture of the abdominal wall under great tension, may be a contributing factor, especially when the suturing is performed by inept hands.

Factors in Technique. While it is generally accepted that increased intra-abdominal pressure in the immediate post-operative period and diseases leading to poor and ineffectual healing are the primary causes of dehiscence, a number of cases are directly attributable to certain factors in the operative technique itself. The surgeon is responsible for: (1) a sterile technique; (2) the choice and type of incision; (3) damage to the tissues; (4) the choice of suture and ligature materials; (5) the type and position of the drainage material employed, and (6) the method of closure of the wound and the use of additional measures to safeguard against undue tension.

Incisions. It is essential, if the surgeon is to limit to a minimum his incidence of disrupted wounds, for him not only to have an irreproachable sterile technique, to inflict the least possible degree of trauma upon the tissues, and to ensure complete hæmostasis and obliteration of all dead spaces, but also so to adapt his technique in those cases which are particularly liable to dehiscence, as for example in patients who are grossly obese or who are bronchitic, anæmic, cachectic, or debilitated from severe septic intoxication, by a careful selection both of the methods of suturing and also of the suture material itself, as his experience in such cases may dictate.

It is interesting to note that in Sokolov's series midline incisions constituted 76.4 per cent of the total number of wound disruptions, 57 per cent occurring above and 43 per cent below the umbilicus. On the other hand, Madelung in analysing his cases in which midline

incisions were employed reported 124 cases below the umbilicus and only 16 above, the explanation here being simple when it is realised that the majority of his operations were gynaecological. Fallis in his analysis of 49 cases of disruption of the wound found that in upper abdominal incisions there were 26 dehiscences, or 53 per cent of the total, and in lower abdominal incisions there were 23, or 47 per cent of the total. These figures conform very closely to Sokolov's, and Fallis considers the difference in his percentages so slight as to appear insignificant. The majority of surgeons, including Lahey, Clute, Colp, Grace, White, Meleney and Howes, believe that disruption is more frequent in upper abdominal incisions, although Howes holds the view that before any generalisations are made the fact that certain operations are gynaecological must be taken into account. Epigastric incisions are undoubtedly subjected to much greater strain and stress as a result of coughing, distension, etc., than those situated in the lower half of the abdomen. No single abdominal incision is exempt from this complication, although rupture is more frequent with some incisions than with others. For instance, it is more common with vertical than with transverse or oblique incisions. I have yet to see a case of disruption following the employment of a transverse epigastric or sub-umbilical (Pfannenstiel) incision. One would have thought that McBurney's gridiron incision would prove an ideal protection anatomically against evisceration, and yet Sokolov was able to cite two such cases in which it occurred, while Maes and his associates reported as many as six cases in a total of forty-four disruptions. That the accident is seen more often in association with midline vertical and with muscle-split incisions than with paramedian incisions has been shown by Fallis who found that nine out of twenty-six upper abdominal ruptures (34 per cent) occurred in section through the linea alba. It is, nevertheless, possible that the vertical midline incision is used more frequently for emergency operations, such as perforated peptic ulcers, and in those conditions where dehiscence is to be feared.

According to Maes, the length of the incision makes no special difference, since wounds heal from side to side and not from end to end; but it would seem obvious that an unduly large incision in an unsuitable subject, such as one who is fat and in whom there is considerable distension, however carefully planned and sutured,

would more readily disrupt than a smaller wound of more judicious length which would still meet the particular requirements of the case.

With regard to the operative procedure itself, Colp writes:

The magnitude and the time consumption of the operative procedure seem of little moment so far as abdominal disruptions are concerned. It may happen after a simple exploration of ten to twenty minutes' duration, or it may occur after a more serious procedure occupying one or two hours. In order to be more specific, there were 172 gastrectomies without an evisceration, yet in 640 explorations, it happened once. In other words, the technical procedure as such can usually be discounted as a potent factor in the causation of wound dehiscence. The fundamental cause cannot be found in the character of the procedure but must be assigned rather to the underlying disease for which the surgery was instituted.²

The performance of more than one operative procedure at a time has a distinct bearing on the increase of disruption of the wound. Fallis writes on this point as follows:

"This is attested by the fact that in this series, 36 of the 49 patients, or 73.5 per cent, were subjected to multiple operations. In some instances, this additional work consisted only of removal of the appendix. When more than one procedure is carried out, the operating time is prolonged and trauma increased, since it is frequently necessary to enlarge the incision or institute vigorous retraction in order to obtain adequate exposure."³

Although this may be so, it has been found in practice that if a sub-umbilical incision has been made for suspected disease of the pelvic organs or appendix, and some other lesion in the upper abdomen is revealed, it is far better to close the primary incision after having dealt with the condition present, and to make another incision in the epigastrium than to prolong unduly the primary incision into this area, and vice versa.

Method of Closure of the Wound. Does the actual method of closure of the abdominal wound and the type of suture material used affect the question of dehiscence? While it is true that rupture is possible with any type of closure and with any type of suture material, it is the opinion of many surgeons that a wise choice of suture mate-

² Colp, *Ann. Surg.*, 99:21, 1934. Courtesy of J. B. Lippincott Co.

³ Fallis, *Surg.*, 1:526, 1937. Courtesy of C. V. Mosby Co.

rial plays a most important part in the matter. I have already shown that the condition is commoner after the employment of particular incisions, and the same may be said when certain suture materials are used. To be more explicit, the incidence of disruption is highest when sutures of plain catgut alone are used to approximate the individual layers of the abdominal wall. Plain catgut is completely absorbed within a few days and therefore should not be used by itself to approximate the peritoneum and posterior rectus sheath or the strong anterior aponeurosis. By hardening catgut, *i.e.*, by chromicising it, absorption is delayed. Some firms which make catgut state that chromic sutures will effectively bind the sutured tissues together for ten, twenty or forty days; but it must be remembered that these claims are based upon experiments upon animals under conditions which do not and cannot compare with those which accompany operations performed upon human beings. It is not possible by any known means to state with confidence whether or not any particular type of catgut can be depended upon to withstand the process of absorption for a long enough period for it to fulfil all that is required of efficient suture material. In cases where disruption occurs on the second or third day, or even at the end of a fortnight, it is common to find that the chromic catgut which has been used for suturing is completely digested, and this has been known to take place even where smears taken from the wound were sterile on culture. In these instances of early dehiscence of the wound and in which the chromic catgut appears to have been completely dissolved, it is very difficult to decide whether its dissolution is dependent upon an idiosyncrasy on the part of the patient to digest catgut rapidly, whether such cases fall into the category described by Eardmann in which, as a result of "tissue hunger," the catgut is absorbed, whether the disruption is due to an inferior grade of catgut, or whether, as Hinton (*Arch. Surg.*, 33:197, 1926) has suggested, it is due to allergy, and the matter as yet remains an open question. Catgut is, nevertheless, extensively used in many clinics throughout the world for suturing abdominal wounds, the usual practice being to employ a continuous suture of No. 0 or No. 1 twenty-day chromic catgut for the posterior sheath and peritoneum, and a continuous suture or interrupted sutures of No. 0 or No. 1 twenty-day chromic catgut for the anterior sheath, the subcutaneous tissues being closed with interrupted su-

tures of No. 0 or No. 00 plain catgut, while the skin edges are brought together with interrupted sutures of fine or medium silkworm gut or silk.

For frankly infected and contaminated cases, catgut is almost universally employed, but in clean cases fine silk, both for ligature and suture, is being used with increasing frequency. Wounds sutured with silk are less likely to rupture than those sutured with catgut, and this, as I have already pointed out, may be attributable largely to the fact that silk is used only in the most favourable types of cases.

Importance has rightly been attached to the question of the need for meticulous approximation of the incision through the peritoneum and posterior sheath of the rectus, and where the aponeurotic sheath is absent below the semilunar fold of Douglas the necessity not only of closing this layer with precision but of anchoring it to the posterior aspect of the bellies of the recti in order to prevent the intrusion of omental tags or the bursting through the suture line of a wedge of omentum, which Freeman (*Arch. Surg.*, 19:600, 1927) justly considers to be one of the primary initiating factors in the rupture of abdominal wounds.

The value of the sole use of through-and-through (all-layers) stay sutures of non-absorbable suture materials, such as thick braided silk, stout silkworm gut or silver or bronze wire for the line of closure of the tissues of the abdominal incision cannot be gainsaid, especially when it is feared that the wound may be subjected to considerable strain at the line of suture through increased intra-abdominal pressure during the post-operative period, when it is suspected that healing may be unduly protracted, or when it is known that the wound has become soiled by septic intestinal contents or peritoneal exudates during operation. This method of suture is therefore recommended in most cases of advanced visceral cancer, in carcinomatosis, in intestinal obstruction, in peritonitis, where there is ascites from any cause, and in certain instances following resection of the stomach, small or large intestine—in fact, in all those cases where it is suspected that healing may be in abeyance or where ordinary suture material such as chromic catgut is unable to withstand either a single or a long-continued assault from abnormally elevated intra-abdominal pressure during the stormy post-operative period which is so often seen in the types of cases enumerated.

This method, which is fully described on page 12, commends itself on account of its simplicity and of the rapidity with which closure can be effected in just those cases in which speed is imperative; again, drainage is free between the sutures, suppuration of the subcutaneous tissues and muscles themselves is minimal, and although separation of the wound is possible, evisceration cannot occur unless the sutures have been placed too widely apart. The resulting wound, although often cross-hatched and "pock-marked," is, in the majority of cases, relatively strong and unyielding.

Drainage. Disruption is commoner in cases which have been drained, although it is interesting to note that the figures of certain surgeons show a higher incidence of disruption in undrained than in drained cases. This may be accounted for by the fact that the number of undrained abdominal wounds is considerably higher than of drained. It would seem almost self-evident, however, that disruption is likely to occur in a higher percentage of drained than of undrained cases, the very necessity for drainage indicating that the patient is suffering from intra-abdominal suppuration with its attendant toxæmia, a combination of factors which, as has been stressed by Colp, is well recognised as being associated with a comparatively high incidence of wound dehiscence. It is probable that drainage tubes are used too frequently, even in cases of mild peritonitis. Nevertheless, in cases of frank peritonitis there are very few surgeons who would have the temerity to dispense with the use of a drainage tube, however dubious they might be as to its actual benefits.

Freeman emphasises that when drainage of the peritoneal cavity is employed, the tissues should be approximated snugly around the tube, not so tightly as to compress the lumen of the tube nor so loosely as to allow a knuckle of gut or a tag of omentum to protrude and become strangulated or to cause an omental wedge to bulge through the interstices of the incision and work its way to the surface and thus predispose to the initial stages of burst abdomen. In all cases of peritonitis, and wherever the wound has obviously become contaminated at the time of operation—however slightly, it is good surgical practice to insert drains into the subcutaneous tissues and even down to though not necessarily through the peritoneal line of closure. When drainage of the peritoneal cavity is indicated, the choice of the exact site for the drainage tube should be determined

by the directness of the approach to the infected region. In certain instances, therefore, drainage tubes should be brought out through the original incision, in others stab drains are obviously preferable. For instance, drainage of the gall-bladder fossa following cholecystectomy or drainage of the common bile duct is better instituted through the original subcostal or paramedian incision than through a stab wound. Again, drainage of the retrocaecal tissues following excision of a ruptured retrocaecal appendix is best provided by a tube which is placed at the lateral margin of the oblique incision which I have already described and which is recommended in such cases, as such a tube is led directly down to the region requiring its use. But in cases of pelvic peritonitis the pelvis can be more satisfactorily drained through a suprapubic stab wound or through the posterior fornix than through a muscle-split incision.

Factors Responsible for Poor Healing of the Tissues.—THE GENERAL STATE OF THE PATIENT. Where the patient is obese, emaciated, aged, decrepit, cachectic, toxæmic, jaundiced, diabetic, nephritic, anæmic, or alcoholic, the regenerative powers of the tissues are much diminished and in such cases extra precautions should be taken to guard against the possibility of disruption of the wound following operation.

THE NATURE OF THE PRIMARY DISEASE. Although Milbert, Glasser and a number of other surgeons consider that increased intra-abdominal pressure is the primary factor in the production of disruption, Colp's view that the primary disease is the most important ætiological factor has many adherents and is extensively supported by statistics. Burst abdomen may occur in any disease which affects the peritoneum or its contents, and as would be expected it is commoner with some diseases than with others. It is well known that illnesses of a protracted nature attended by emaciation, anæmia, cachexia and weakness, and those of acute or chronic intoxication associated with long bouts of fever, devitalise the individual sufficiently to interfere with the reparative powers of the tissues and healing of the wound. The condition is therefore most commonly seen after operations for visceral cancer, inflammatory diseases of the gall-bladder and bile passages, gynæcological diseases such as fibroids, acute appendicitis, intra-peritoneal suppuration (generalised or localised), acute pancreatitis, and ascites. The comparatively high incidence following

operations for cancer of the abdominal viscera is due in large measure to the toxemia, anæmia and debility often present in such cases, although 28 per cent of Colp's cases occurred after operations for carcinoma. Starr and Nason (*J. Am. M. Ass.*, 100:310, 1933) reported as high an incidence as 40 per cent of their total number of cases. The condition is often seen after gall-bladder operations, as many of these patients are obese and flabby, and suffer from hepatic or renal damage which of itself so often produces a condition of poor healing. Again, in uterine fibroids there is often a mild secondary anæmia and secondary metabolic disturbances, while in acute hæmorrhagic pancreatitis, dehiscence can often be traced to the action of escaping digestive ferments upon the suture material.

Acute appendicitis and peritonitis furnish a number of cases, as suppuration of the wound is here common, peritoneal drainage is frequently required, and other factors such as septic intoxication and marked debility are often associated with such mechanical disruptive forces as coughing, vomiting and distension, which all combine to play an important part in causing the accident.

Increased Post-Operative Abdominal Pressure. Many surgeons agree with Milbert and Glasser (*Am. J. Surg.*, 32:63, 1936) that this is one of the most important underlying causes of disruption of the wound. There can be no doubt that post-operative vomiting, meteorism, hiccough, explosive coughing, violent sneezing, and any undue strain such as might be occasioned by restlessness, by the patient getting out of bed, or by difficulty in defæcation or micturition, as well as the straining associated with gastric lavage, impose upon freshly sutured abdominal wounds stress which is sufficient at times to cause disruption. Where healing is, for one reason or another, poor, such as may be the case in the presence of sepsis, malnutrition, etc., or where the suture material used or the method of suturing is unsuitable for the special needs of the case, disruption is to be anticipated, particularly when the intra-abdominal pressure is of great force or is continuous.

Clinical Picture of Burst Abdomen. There are many clinical types of burst abdomen, but the post-operative course is seldom uncomplicated in any of them, even where rupture occurs without any apparent warning. There is a type in which the patient's progress appears to be satisfactory, although the temperature may be slightly raised

and meteorism may have been troublesome. When the stitches are removed on the seventh or eighth day, the wound literally falls apart, or a day or two after the removal of the sutures the dressings, and sometimes even the binder and bed-clothes, are drenched with a pink sero-sanguineous discharge. This pink discharge is almost pathognomonic of dehiscence, and when it occurs early, *i.e.*, before the seventh day, the wound should be examined, a stitch or two removed, the edges of the wound gently separated with a probe, and the deeper layers inspected to see whether union is satisfactory. Sometimes this pink discharge is associated with a large subcutaneous hæmatoma or a soft, tympanitic, boggy swelling which distends the wound. Both these types of cases should be investigated in the operating theatre, and if a large hæmatoma has formed it should be evacuated and the depths of the wound examined to see if any separation has occurred. The soft tympanitic swelling generally denotes that a knuckle of gut has burst through all the layers of the abdominal wall and lies under the skin incision; but although this may still remain intact the condition is in itself an indication that immediate repair is imperative.

There is another type in which the wound appears to be soundly healed. There may or may not be the pink discharge which I have described, but the patient, following some excessive strain, may feel a sudden "give" in the wound, which, when examined, is found to be torn asunder and the gut eviscerated. It is surprising how painless this condition may be, and how little if any shock results; shock, in fact, is rarely seen in cases of dehiscence of the wound except where evisceration is extensive, sudden and profuse. In cases where the edges of the skin incision have separated, the surgeon after having inspected and probed the depths of the wound may often lull himself into the belief that what he is seeing is actually rectus sheath or muscle fibres coated with fibrinous clot. More often than not, however, it is the omentum, the transverse colon, or a portion of the small intestine which is protruding into the depths of the wound, and the best way of ascertaining the truth is to explore the wound in the operating theatre with the patient under a spinal anæsthetic, always provided that his condition permits of such a procedure.

In another type of case the immediate post-operative course is very stormy, and it should be noted that patients who take anæsthetics

badly often have a stormy convalescence. There is usually considerable post-operative vomiting and marked distension, hiccough may be troublesome, respiratory complications are frequent, and supuration of the wound is common.

Where post-operative rupture occurs in a wound which is frankly suppurating, the onset is nearly always gradual. An abscess forms which is usually drained, and in the discharge portions of the sloughing aponeurotic sheath or fibres of muscle are carried away, this being followed by separation of the deeper layers. Here the matted omentum and intestine are often adherent to the necrotic muscle.

Extensive evisceration, where the intestines literally prolapse into the bed, is rarely seen except where large incisions have been made with the object of exploring the abdominal cavity in cases of visceral carcinoma.

Disruption generally follows the removal of the sutures on the seventh or eighth day, but it may occur later (on the fourteenth day) when supporting or stay sutures have been used, or even later than this after the wound appears to be soundly healed, especially in cases of visceral cancer and ascites, or where suppuration is a late complication. It is rare for disruption to take place before the skin sutures have been removed, but when it does occur prior to this and is treated promptly the prognosis is usually hopeful.

Prognosis. As previously stated, the mortality of this condition has been computed by different authorities as being between 25 per cent and 75 per cent, the average being 30 to 40 per cent. The earlier the accident is recognised and treated, the better will be the prognosis, and especially in clean cases where the dehiscence is partial or, if complete, is not associated with prolapse of the intestine. Where there is extensive suppuration of the wound or general peritonitis, the prognosis is very grave. The commonest causes of death may be listed in their order of frequency and importance as follows: Peritonitis, post-operative shock, pneumonia, intestinal obstruction, hæmorrhage, and acute dilatation. The primary condition for which the patient was operated upon is more often the exciting cause of death than the rupture itself or the measures required in its treatment. It is found that packing and strapping the wound are associated with a lower mortality than primary suture.

Treatment. There are three methods in common use today.

1. Packing the wound followed by strapping with adhesive plaster.
2. Temporary packing and strapping followed by secondary suture.
3. Immediate secondary suture.

Packing and strapping the wound is indicated:

(a) Where the patient's condition is such that any secondary operative procedure would be too hazardous, *i.e.*, he is in a critical state and perhaps suffering from shock.

(b) Where the disrupted wound is very foul and freely suppurating.

(c) Where the disruption has involved only a very small area.

(d) Where on prying into the depths of the wound it is seen that separation of the muscles is minimal and that the abdominal contents are prevented from further protrusion by being firmly adherent to the deeper tissues.

(e) Where disruption has occurred in a case of frank purulent peritonitis.

Therefore in the very mild case where a portion of the wound gapes and also in the very severe critical case, strapping is to be preferred to immediate secondary suture. In the desperate case the problem is to get the patient safely through the immediate crisis with the least possible interference. As soon as he has recovered from the early effects of the wound disruption and of the treatment by strapping, and provided there is no evidence of infection, secondary suture, when indicated, may then be carried out with much less risk. It is true that post-operative hernia is much more commonly seen after this method of treatment, but this can be repaired at a later date with comparative safety and success.

Where strapping is indicated, the patient should be given an injection of $\frac{1}{3}$ gr. omnopon with $\frac{1}{150}$ gr. scopolamine or some narcotic drug, and when he is under the influence of this the wound edges and any protruding viscera should be freely washed in normal saline and then painted with a 2 per cent solution of aqueous mercurochrome. After this the omentum and gut should be gently replaced down to the level of the edges of the peritoneum. A long strip of gauze soaked in paraffin and flavine or raw cod liver oil is then gently placed on top of the repositied viscera, and the skin edges are closely approximated with lengths of flamed adhesive plaster and a firm

dressing applied. This procedure is almost painless, the patient need not be removed to the theatre, no anæsthetic is required, and, what is more, it is simple and can be performed easily and expeditiously. Free peritoneal drainage is afforded by the gauze which protrudes through the lowest portion of the wound. If all goes well, the plaster and the gauze dressing are removed in a few days, and the process is repeated at intervals until sound healing is well advanced. Secondary suture may be contemplated at this stage, but if deemed inadvisable the wound is allowed to granulate slowly and cleanly.

Immediate secondary suture of the disrupted wound is recommended for comparatively clean cases in patients who are not gravely ill. It may also be advised for those cases where shock is absent or, if present, is responding readily to treatment; where sepsis is controllable; where the patient's general condition suggests that an anæsthetic will be well tolerated; where the accident has occurred early in the post-operative phase and is recognised promptly; and where the marked œdema of the abdominal wall, the total disappearance of catgut sutures, lateral retraction of the posterior sheath and peritoneum, and an excessive outpouring of serum suggest that the condition is due to an allergic reaction.

As soon as the condition is recognised, the wound and protruding viscera are freely bathed with warm normal saline solution and covered with large sterile towels wrung out in the same solution, over which a many-tailed bandage is lightly applied. The patient is given a narcotic and is told that he must not cough or strain, an attempt also being made to reassure him that his condition will very shortly be righted by resuturing the wound. Efforts at replacing the protruding viscera should not be repeated if the first attempt is painful or is *resented by the patient, as perseverance in such circumstances may result in more straining and even further evisceration.*

When the patient has been moved to the operating theatre he is given a spinal anæsthetic. Some surgeons, however, prefer to effect closure with the aid of a local anæsthetic, or even with the intravenous injection of such drugs as evipan or pentothal. After the binder and the dressings have been removed, the surrounding skin and prolapsed viscera are again washed with saline solution. The edges of the abdominal wall are then lifted upward and the prolapsed gut is replaced below the level of the peritoneal edges. At this stage the

wound is mopped dry, disintegrated fragments of catgut are extracted, and the edges of the wound are freshened up by brisk friction with dry gauze. It will be noted in many cases that the edges of the wound are very swollen and boggy, and that the peritoneum and posterior sheath of the rectus muscle are glued together and retracted outward, a state of affairs which immediately suggests that any thought of suturing layer by layer is quite out of the question. Were this attempted, the surgeon would in any case at once realise that the tissues were too friable and cheesy to permit of it. If only a very small area of the wound has disrupted, this portion alone should be sutured. If, however, more than half has torn asunder, the correct procedure is to open up the remaining part and suture the whole wound afresh.

Hook retractors are placed at each extremity of the wound and these are handed to an assistant whose sole duty is to exert firm upward traction, not only during the introduction of the sutures but until the last through-and-through suture has been tied, at which stage the retractors are removed. A Cripps' pad well soaked in warm saline solution or a McNeill Love rubber guard is placed in the wound on the surface of the viscera and inserted under the edges of the peritoneum in order to keep the viscera well away from the wound while it is being sutured. The sutures will consist of No. 8 plaited silk, No. 8 deknoted, or bronze or silver wire. They are inserted 1 inch from the margin of the wound and about 1 inch apart, and are made to transfix all the layers of the abdominal wall on both margins of the wound. As they are introduced, the free ends are clipped with hæmostats. The silk sutures should be threaded with fine rubber tubing and gently but firmly tied, while the ends of the metallic sutures are lifted up and twisted together on one side of the wound until the necessary tension is obtained. They are then clipped fairly short and their spiky ends are blunted by twisting them over.

Drainage is not required as the gaps between the sutures give free vent to any discharge. The wound is then freely painted with acetone-alcohol-mercurochrome, and a voluminous gauze dressing is applied and firmly fixed in position by a bandage. The wound will subsequently require daily dressing. The through-and-through sutures are not removed until the fourteenth to the eighteenth day, after which

the wound will require further support by means of a special adhesive corset.

Keloid. There is no doubt that some persons have a greater tendency to produce keloid scars than others. The condition is particularly common in negroid races. Tuberculous patients and those who are said to have the "strumous diathesis" are also frequent victims. The appearances are unmistakable: The scar is shiny, pink or red, raised above the level of the surrounding skin, firm and hard, with a surface which may be smooth, rough or grooved. It has irregular "feelers" projecting laterally from the parent stem. The various marks made by the needle while suturing the skin are likewise keloid, being red, shotty and angry-looking. Although the margins of a keloid may appear sharply defined, they are not actually so, and on palpation the hardened, knotty scar tissue can be felt spreading downward from the surface into the subcutaneous tissues and in some cases even into the deep fascia and muscles. A keloid scar has the microscopical appearance of a soft fibroma and never becomes malignant.

Treatment. It should be stated as a definite rule that keloid scars should not be excised unless appropriate measures, *e.g.*, irradiation, are taken to prevent their recurrence. If excision alone is undertaken, the keloid inevitably reappears. The slight cases may well be left alone, as many of them tend to clear up spontaneously. In the more severe cases the keloid is excised, X-rays or radium in small doses being employed both before excision is performed and after removal of the sutures. It should be emphasised, however, that screening must be efficient, as certain organs, such as the liver and ovary, are very susceptible to X-rays and radium, and that great care must be taken not to burn the patient. Several treatments with small doses is a safer method than fewer treatments with massive dosage.

Post-Operative Progressive Bacterial Synergistic Gangrene. This is a rare complication of the wound and less than fifty cases have been reported to date. The condition must, however, be more common than the literature would suggest, as I have had two cases in my own practice and have seen three others occurring in the practices of other surgeons. None of these cases was reported.

Cullen (*Surg., Gynec. & Obst.*, 38:579, 1924) was the first surgeon to draw attention to this interesting complication and to give an accurate clinical picture of the condition. He described vividly the

havoc wrought to the abdominal wall in a case of his which occurred after the drainage of an abdominal abscess. Stewart-Wallace (*Brit. J. Surg.*, 22:642, 1935) collected from the literature thirty-seven cases of post-operative progressive gangrene of the skin, and since then additional cases have been reported by Meleney, Willard, Horsley, Holman, Hicken, Coakley and Klein, Liedberg, Wakeley and others. Meleney (*Surg., Gynec. & Obst.*, 56:847, 1933) has classified the various types of infectious gangrene of the skin as acute and chronic. The acute forms are represented by gas gangrene and hæmolytic streptococcal gangrene, while the chronic forms include ecthyma, amœbic gangrene and post-operative progressive bacterial synergistic gangrene.

For our present purpose only the last two conditions concern us, and of these amœbic gangrene may be rapidly dismissed by stating that it may occur after drainage of a liver abscess and responds promptly and satisfactorily to emetine medication. The majority of the reported cases of post-operative synergistic gangrene have followed drainage of a deep-seated peritoneal abscess, while a fair number have occurred after the drainage of an appendix abscess or after a straightforward appendicectomy associated with suppuration localised to the right iliac fossa.

The first sign of the inauguration of the gangrenous process occurs during the first or second week after operation, although rare cases have been known in which it has shown itself as early as the first or second day or as late as the twenty-first day, when the wound and the stitch holes take on a carbuncular appearance and become so exquisitely tender that the application of even the most soothing dressings can hardly be tolerated. In the early stages the patient's general condition appears to be satisfactory, although his temperature may be slightly raised; but as the process continues its aggressively relentless course he gradually becomes worn out with the anxiety that something serious is amiss, with discouragement on seeing the disease spread rapidly in spite of constant attention, and by intractable pain. The first noticeable change in the wound is that it becomes sore, red and tender. In the course of a few days the process very slowly extends, and the central area becomes purple or mauve-coloured, while the outer zone is tinted brilliant red or vermillion. Later on the purplish zone spreads outward and the part

first affected shows all the signs of gangrene. The dead, black or mud-brown, leathery, liquefying sloughs of skin bathed in thin watery pus undergo a slow but steady disintegration which on separating leaves a comparatively healthy base covered with pale-pink water-logged granulation tissue. The purple area creeps outward into the red zone, and as it does so this spreading edge becomes raised and œdematous. It advances slowly without respite unless checked in its career by surgical measures. If this spreading edge is examined closely it will be seen that the central portion of the purple zone, *i.e.*, the part that lies close to the gangrenous area, is well defined but irregular, crenated, and here and there slightly undermined, although undermining is not a prominent feature. On the other side it fades off into the red zone, and eventually flattens to the level of the healthy skin. In certain places the edges show a tendency to heal and become shelving and non-œdematous, while virile epithelium grows across the base to meet islets of deep epithelium which have sprung from hair follicles or sweat glands which have not been destroyed.

Meleney (*Ann. Surg.*, 91:961, 1931), whose work is the most important contribution toward the understanding of the ætiological factors of this condition, concludes that chronic progressive post-operative gangrene of the skin is caused by synergistic activity of a symbiosis of a specific micro-ærophilic non-hæmolytic streptococcus present in pleural or peritoneal exudate and a non-specific staphylococcus introduced from without—usually from the patient's skin, and this opinion has since been confirmed by many other workers in this field.

Treatment. As in a certain number of cases the infection appears to start around the tension sutures or in sutures which have been tied too tightly, it has been suggested that as a prophylactic measure all skin wounds should be left unsutured when a deep peritoneal abscess is drained, or at least that tension sutures should not be employed. Meleney remarks that the chronicity of the infection has afforded surgeons the opportunity of trying to cure it by many methods, and that certain of the reports which have been published in the literature reflect ingenuity and perseverance in trying all sorts of chemical, physical and serological agents, both generally and locally, in the face of a baffling problem. In nearly every case con-

servative measures have failed dismally to check the advance of the process which in some instances has involved almost the entire trunk. The radical excision of the lesion in the early stages, or complete removal of the advancing edge including the other zone of redness when more extensive, has almost invariably resulted in prompt disappearance of the disease. An incision should be made with the cautery knife, well beyond the advancing margin, through healthy skin, down to the muscle layer to circumscribe the lesion, and the entire edge be removed. If the lesion is very extensive, the excision may have to be done in more than one stage.

Zinc peroxide suspended in distilled water and applied to the wound will help to prevent a recurrence of the infection and also to promote a clean, granulating surface. The defect left by the radical excision and by the loss of skin through gangrene may then be very quickly and efficiently restored by Thiersch, or preferably pinch, skin grafts.

Although the surgeon interested in abdominal work may see but few instances of this condition which I have described, he should, nevertheless, bear it in mind, and when spreading gangrene occurs in a wound following the drainage of a peritoneal abscess he should promptly excise the whole infected area without question or hesitation.

PART II

STOMACH AND DUODENUM

CHAPTER I

ACUTE DILATATION OF THE STOMACH

Acute dilatation is a condition in which there is a sudden and often excessive enlargement of the stomach due to an accumulation of gas and fluid, followed by regurgitant vomiting, progressive dehydration and collapse. Death often ensues if appropriate treatment is not promptly instituted. In surgical text-books it is often stated that the condition is rare, but with this I cannot agree, my reason being that very few of the cases which occur are recorded and quite a large number are unrecognised.

At present there does not seem to be universal acceptance of any of the theories put forward to explain the pathogenesis and aetiology of the condition or of its associated phenomena. Rokitsansky (1861), Albrecht (1899) and Connor (1907) warmly supported the view that acute dilatation was due to an obstruction of the third portion of the duodenum caused by constriction of the mesenteric root, while Campbell Thomson (1902), Borchgrevink (1913) and Doolin (1918) consider that there is a primary paralysis or paralytic ileus involving the stomach wall, this being followed by dilatation. Borchgrevink (*Surg., Gynec. & Obst.*, 16:662, 1913), in a paper replete with valuable information, maintained that the paralysed and dilated stomach produced a secondary mechanical occlusion of the duodenum, either by direct pressure on the duodenum in its passage over the spinal column or by secondary arterio-mesenteric compression brought about by the downward pressure of the dilated stomach which pushes the coils of small intestine into the hollow of the pelvis. Dragstedt and his co-workers (*Surg., Gynec. & Obst.*, 52:1075, 1931) have shown that in these cases death is due to failure of the process of the reabsorption of gastric and pancreatic juices, and more particularly of the inorganic elements, sodium and chlorine, which are excreted in these fluids. This lack of reabsorption is the result of inability of the atonic stomach and duodenum to propel these secretions into the lower jejunum, ileum and colon, where their

absorption can take place. The gastric and duodenal mucosa does not absorb these digestive juices.

Both sexes are equally affected, and no age is exempt since the condition has been noticed in an infant of a few months and in a patient eighty years of age.

Incidence. Acute dilatation of the stomach may occur:

During Abdominal Operations. From a perusal of the descriptions of the cases that have occurred during abdominal operations, the impression gained is that some of them may have been due to such causes as swallowing air or to gas being forced into the stomach under great pressure during anaesthesia.

Richardson and Lee have both recorded interesting cases where dilatation commenced with startling suddenness during the course of an operation. Richardson's case was one of perforated duodenal ulcer which was operated upon and the perforation closed. At the commencement of the operation the stomach was small and collapsed, but while the abdominal wall was being closed it became so rapidly distended that this portion of the operation was difficult. The stomach was found to be drum-like and tense and as the distension increased it rolled upwards. On the passage of a stomach tube vast quantities of gas were passed, the stomach rapidly collapsed and the patient recovered. Lee's case also followed an operation upon the stomach. There was a chronic pyloric ulcer associated with stenosis for which a posterior gastro-enterostomy was performed. The dilatation developed during the course of the operation and the patient died. As Lee points out, this case was of special interest in proving that an acute dilatation could occur in spite of the fact that a posterior gastro-enterostomy had been performed.¹

After Abdominal Operations. Between 65 and 70 per cent of all recorded cases have followed abdominal operations. The condition is most commonly seen after operations upon the pelvic organs, and then in order of frequency after operations upon the gall-bladder and bile passages, the appendix, for hernia, and upon the stomach. Not more than 5 per cent of cases are seen after operations upon the stomach and duodenum, and as acute dilatation of the stomach may occur after gastro-enterostomy it is futile to adopt this procedure in order to overcome the condition.

After Operations upon the Extremities. I have known this complication to occur after the amputation of an arm which had been severely crushed. Dragstedt stated that the occurrence of acute dila-

¹ Walton, *Textbook of the Surgical Dyspepsias*, 305, 1930, London, E. Arnold Co.

tation which followed injuries and such extra-abdominal operations as those on the extremities and face, indicated that profound stimulation of both somatic and visceral sensory nerves might cause reflex inhibition of the stomach. There is sufficient experimental evidence to show how the trauma incident to laparotomy, or any operative injury, or childbirth, might bring about marked inhibition of the vagus and stimulation of sympathetic nerves to the stomach.

Following any Abdominal Injury or Fracture of one of the Limbs. I have seen two cases follow the setting of a severe fracture of the femur.

After Childbirth.

During an Acute Illness. Cases have been known to occur after the crisis of pneumonia, during typhoid fever, and in patients recovering from acute septicæmia.

During chronic illnesses and debilitating diseases, such as phthisis, diabetes, chronic nephritis, chronic pancreatitis, etc.

Immediately Following the Rapid Ingestion of a Large Meal or after an Excessive Bout of Drinking.

After Genito-Urinary Operations. The condition is not infrequently seen after operations upon the prostate gland and kidney, and Dragstedt states that it may even follow the catheterisation of the ureters.

In persons with spinal deformities or certain spinal diseases, e.g., tuberculosis of the spine, spondylitis deformans, syphilitic myelitis, etc.

MORRID ANATOMY

The appearances as seen at post-mortem examination are quite characteristic (fig. 10). The enormously distended stomach will be found to occupy practically the whole of the abdominal cavity, and apart from the stomach usually only the liver and gall-bladder can be seen, as the intestines are crammed into the pelvis or are hidden from view behind the blown-out stomach. The stomach is ballooned and drum-like and has a very large descending left limb which may extend into the pelvis, and a smaller ascending right limb which hooks under the right lobe of the liver; it is U- or V-shaped, and at a point corresponding to the incisura there is a deep indentation. When the surface of the organ is examined it will be found to be

covered with striæ which are no doubt due to over-distension. Its walls are very thin, and in some instances actually transparent so that the liquid contents can be seen. There is usually no evidence of peritonitis either in the region of the stomach or in any other part of the abdominal cavity. When the stomach is incised a large

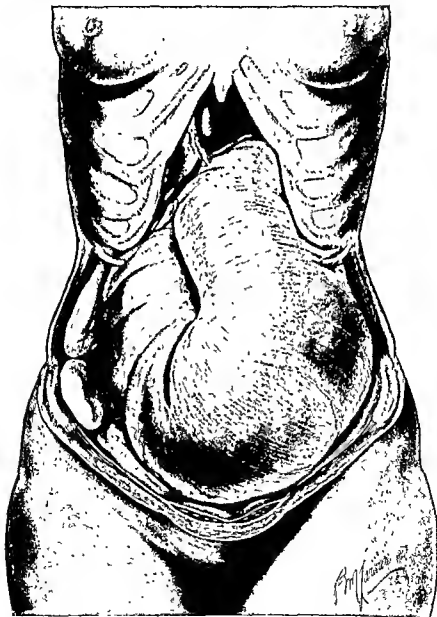


FIG. 10.—ACUTE DILATATION OF THE STOMACH—POST-MORTEM APPEARANCES.

quantity of gas and evil-smelling dark fluid will be evacuated, and it will then be observed that its walls are of tissue-paper thinness, soft and friable, and the mucous membrane flattened out so that no rugæ can be discerned. Scattered over the surface of the mucous membrane are numerous little pits or small erosions which account for the black material that is vomited during the final stages. In some instances the dilatation does not extend beyond the pylorus, but in the majority it will be seen to involve the duodenum and to end abruptly where the mesenteric blood-vessels cross over it. Sometimes the constriction caused by the root of the mesentery may be so tight as to lead to necrosis of the mucous membrane of the duodenum, a fact which has been commented upon by Baumbler and other observers. In a few cases, however, the upper coils of jejunum share in the dilatation and when this occurs it is obvious that mesenteric compression is not an important ætiological factor in its production.

CLINICAL PICTURE

The condition usually starts forty-two to seventy-two hours after operation although it may be delayed for as long as two to three weeks. It has been known to occur during or immediately after an abdominal operation, but more commonly arises during the second post-operative day. The most prominent signs and symptoms are abdominal distension, regurgitant vomiting, and toxæmia with collapse. The distension is preceded and accompanied by nausea, pain, and a sensation of tightness and fullness in the epigastrium. The pain, however, is not severe and rarely amounts to anything more than a feeling of discomfort or of pressure. In severe cases where the distension is extreme, pain is ominously absent. The dilatation may appear gradually and insidiously or with manifest rapidity. It is at first most noticeable in the upper abdomen where it may remain localised for a while. Then the left flank and the hypogastrium become inflated, until eventually the whole abdomen is tensely drum-like and blown out to its fullest capacity. As in cases of adynamic ileus, visible or audible peristalsis is absent. If the stomach is fully distended with gas, percussion will produce a resonance in the epigastrium and over the lower half of the left side of the chest, and the heart will be pushed upward and embarrassed in its action. When

the stomach is full of fluid and regurgitant vomiting is a troublesome feature, the upper half or even the whole of the abdomen will be dull on percussion and a succussion splash will be clearly elicited. At first the vomiting may be indistinguishable from post-anæsthetic sickness, especially when the patient has received a large quantity of ether or chloroform; but after a time it becomes characteristically frequent, effortless and involuntary. The fluid wells up into the mouth, spills over the lips and gushes from the corners of the mouth, while, during some of the brave paroxysmal attempts on the part of the patient to expel the putrid and acrid contents of his stomach, a filthy, black or brownish-green stream of cadaveric-smelling fluid will pour from his widely open mouth and dilated nostrils. The mouth becomes painful and seared, and the eroding constituents of the voided, decomposing gastric, duodenal and miliary juices burn the cheeks and corners of the mouth. The vomiting is never projectile, and in 10 per cent of the cases it is entirely absent. It may at times be a late manifestation and not occur until the limit of distension has been reached. The vomited material is at first colourless or opalescent, being later bile-stained—green or yellow, eventually becoming dark brown or even black. In the late phases it invariably resembles coffee grounds owing to the presence of altered blood. It is never feculent, but may possess a peculiar sweet musty odour. As much as several pints may be vomited during the course of a few hours, and although when a stomach tube is passed quarts of fluid may be withdrawn, within a short while the stomach may refill again to overflowing.

After a variable period signs of toxæmia, dehydration and collapse are prominent. The patient is pale or ashen-grey in colour, and the eyes, which are surrounded by dark rings, become hollow and blood-shot and move actively, anxiously and attentively. Although the patient is exhausted almost to breaking point and feeble through incessant vomiting, his mind remains alert until delirium or coma supervenes. Hearing is acute and the memory retentive. The pulse is racing and weak and rapidly mounts, while in a severe case it may become imperceptible at the wrist. The temperature is sub-normal, and the respirations are quickened and thoracic in nature. The patient feels icy cold and shivery, the extremities are numbed and death-like, and the whole body is drenched in perspiration. Owing

to the excessive loss of fluids through the patient's inability to drink, through vomiting, and through sweating, thirst becomes insatiable. Hiccough may be troublesome and persistent in the early stages of a mild case, but is rarely, if ever, seen in the grave or advanced case. The bowels are usually constipated, although occasionally there may be incontinence of watery feces. There may be retention or suppression of urine, or the urine may be passed infrequently in small quantities, when it will be found on examination to be highly concentrated, of a rich mahogany colour and loaded with urates. An examination of the blood at this stage will reveal a severe degree of alkalosis. The carbon dioxide combining power of the blood and the non-protein nitrogen are raised and the blood chlorides are low. Unless the patient is treated promptly along the correct lines, death will usually follow within two to five days.

DIAGNOSIS

If the condition is borne in mind, very few cases will pass unrecognised. The diagnosis is, as a rule, simple. The occurrence early in the post-operative period of epigastric distension, the effortless regurgitant vomiting of greenish-brown or black material, the splashing sounds which are elicited on palpation of the abdomen, the rapid development of dehydration and toxæmia, the absence of fever, abdominal rigidity and visible peristalsis, the enormous quantities of fluid and gas which can be withdrawn from the stomach by means of a stomach tube, should all immediately arouse strong suspicions of the condition present.

The following conditions are sometimes mistaken for acute dilatation of the stomach: high obstruction of the small gut; septic peritonitis; acute ileus occurring in other parts of the intestinal tract; persistent post-anæsthetic vomiting; acidosis; alkalosis; uræmia; intra-peritoneal hæmorrhage, and acute poisoning by drugs.

PROGNOSIS

As the chances of spontaneous cure are very slight, the results in undiagnosed cases are almost invariably fatal. Connor (*Am. J. M. Sc.*, 133:345, 1907) on analysing all the recorded cases up to that date

found that the mortality was 72 per cent. Laffer's figures (1908) show the death-rate to be 67.5 per cent, while Borchgrevink (1913) recorded 144 cases of which 54 per cent of the patients died. Doolin writes:

Within the past ten years there is an improving prognosis, largely depending upon more widespread recognition of the condition and better methods of treatment. We get a truer perception of the patient's chances if we analyse the mortality of the various methods of treatment adopted:

- (1) Of 31 cases treated medically, 29 died, a mortality of 93%.
- (2) Of 29 cases treated by operation, 21 died, a mortality of 72%.
- (3) Of 51 cases treated by lavage, 25 died, a mortality of nearly 50%.
- (4) Of 30 cases treated by posture, 2 died, a mortality of nearly 7%.

Thus of 114 cases where postural treatment was not carried out, 75 died, giving a combined mortality of 65%; whereas in the 30 cases where postural treatment was adopted, the mortality is reduced with a jump to below 7%.²

Recently great strides have been made in the management of these cases, and provided the condition is recognised early and treated on the lines about to be described, death from acute dilatation of the stomach alone should occur only on rare occasions.

TREATMENT

As the stomach contents are watery in nature, a Levine or a small-bore Ryle stomach tube should be used for aspiration and irrigation. The tube, which is passed through the nostril or the mouth, should be strapped to the side of the face with adhesive tape, and aspiration and irrigation instituted. With the tube in place, aspiration followed by lavage with normal saline solution should be repeated every two to three hours both by day and by night until improvement is evidenced by a diminution in the amount of secretion, by its lighter colour, and by its less offensive odour. When this occurs, the intervals between the aspirations are prolonged, say, to five or six hours. The tube should, if possible, be left in situ for forty-eight hours or even longer. If patients find the continued presence of this tube intolerable, it may be necessary to pass it four-hourly and then at gradually lengthening intervals. The suction-siphonage apparatus of Wangensteen or Curphey and Orr's modification has proved to be

² Doolin, *Brit. J. Surg.*, 21:125, 1918.

the ideal method of managing these cases. With a nasal tube in place it is possible for the patient to expedite his recovery by drinking as much water as possible. All the water, toxic gastric and duodenal secretions and gas are promptly removed by the continuous suction of the stomach tube.

Equal in importance to gastric aspiration and lavage or continuous suction siphonage by Wangensteen's apparatus are the measures instituted to combat dehydration, toxæmia and alkalosis. Owing to the amount of fluid lost by vomiting and sweating, it is important to replace this by giving large quantities of saline solution with 5 to 10 per cent glucose. By these means the blood pressure is rapidly restored, the failing circulation is re-established by the refilling of the vascular system, and alkalosis is combated.

It is best to give these fluids intravenously by the slow drip method, and an attempt should be made to introduce from 2 to 3 litres daily for several days. Frequent chemical examinations of the blood should be made, and as soon as the blood chlorides show a return to normal, the saline infusions with glucose should be stopped and a 5 per cent solution of glucose in distilled water be substituted.

There are no specific drugs used in the treatment of acute dilatation of the stomach, but morphia, gr. $\frac{1}{4}$, should be given to relieve the pain and to induce sleep. As soon as it is clear that the stomach and intestines are regaining their tone, 1 cc. of pituitrin may be injected every three hours for three doses to aid bowel movements and the passage of wind.

In certain cases postural treatment may be employed with advantage, but during the last two years I have tended to abandon this method of treatment on account of the distress which it often occasions the patient.

CHAPTER 2

ACUTE PHLEGMONOUS GASTRITIS

Acute phlegmonous gastritis, occasionally termed acute suppurative cellulitis of the stomach or gastric phlegmon, is a severe inflammatory process involving chiefly the submucosa and progressing to purulent infiltration and even to necrosis of the stomach wall. Two forms of the condition are recognised: the diffuse and the circumscribed. The diffuse form occurs twice as frequently as the circumscribed. In the former, the whole stomach is involved in an acute diffuse suppurative process, while in the latter the suppuration is limited to one portion of the stomach, where an abscess may form which may rupture into the stomach or into the peritoneal cavity. It is in connection with the attenuated or localised form that the subacute or chronic varieties of the disease are seen.

According to Leith, the first reference to this disease was made in 1620 by Varandalus who described a localised case. It was not until 1839 that the diffuse form was recorded by Andral, and later, in 1861, by Cruveilhier. Sundberg (*Nord. med. Ark.*, 51:303, 1919) was able to collect 215 cases from the literature, while in 1927 Gerster (*Ann. Surg.*, 85:668, 1927) recorded an additional 48 cases and gave an accurate account of the pathology of the disease. Watson (*Am. J. Surg.*, 18:113, 1932) in a masterly review of the subject stated that 276 cases, including one of his own, had been reported up to 1932. The figures have risen to close upon 300, and a series of interesting cases have been described by Coghill (*Lancet*, 1:116, 1934), Jennings Marshall (*Brit. J. Surg.*, 22:629, 1935) and Graves (*Canad. M. Ass. J.*, 29:37, 1933). A recent authoritative account of this disease together with a full bibliography is given by Eliason and Murray Wright (*Surg. Clin. N. Am.*, 1553, Dec., 1938).

The disease undoubtedly is rare, and so far as I can ascertain it has never been correctly diagnosed prior to opening the abdomen either at operation or at autopsy. It is probable that many of the less severe cases pass unrecognised and the patients recover completely.

Acute phlegmonous gastritis may occur at any age and has been known to affect a child of eleven and a patient of seventy. As a rule, however, those affected are young adults, the majority being between the ages of twenty-five and thirty-five. Males are more prone to the infection than females, and Adams considers that the proportion is approximately 5:1.

The disease is stated to be *primary or idiopathic* when there appears to be no breach in the mucous membrane, and *secondary* when there is an obvious lesion through which the suppurative process spreads, e.g., peptic ulcer, cancer of the stomach, operative or other trauma of the stomach, acute or chronic gastritis with erosions, or the ingestion of poisons or coarse foods which may injure the mucosa. The majority of cases falling into the primary or idiopathic class are of metastatic origin, being associated with some generalised infection. Here the organisms reach the loose submucous space, which is richly supplied with lymphatics, and light up a spreading cellulitis. They may with difficulty pass through a healthy intact gastric mucosa, but they will do so more readily if this lining is eroded with tiny acute ulcers or is the seat of a purulent gastritis. Pritchard and McRoberts write: "That organisms may pass through the stomach mucosa in cases in which infected material is swallowed is suggested by the fact that phlegmonous gastritis has been seen following stomatitis, purulent bronchitis, drainage of abscesses in the oral pharynx, extraction of carious teeth, and the eating of infected food."¹

That the infection may in certain instances be blood-borne is evidenced by the fact that the condition has been known to follow erysipelas, small-pox, scarlet fever, furunculosis, pyæmia, and acute polyarthritís, while Gerster states that during an epidemic of puerperal sepsis in Prague in 1847 several cases of phlegmonous gastritis were noted. A careful study of the reported cases shows that chronic gastritis is a feature which has characterised many of them. Sundberg states that there was a history of catarrhal gastritis in all his seventeen cases. Acute gastritis is generally considered to be a predisposing factor when this complication arises in the course of any of the acute infectious diseases. Debility, e.g., through starvation, may also play an important part in its production. All observers are agreed that in about 70 to 80 per cent of cases streptococci are the invading organ-

¹ Pritchard and McRoberts, *Canad. M. Ass. J.*, 25:186, 1931.

isms, while in the remainder pneumococci, staphylococci, *B. coli*, *B. proteus*, *B. subtilis*, or *B. aerogenes capsulatus* may be found singly or in combination.

PATHIOLOGY

The stomach, as viewed at operation or at autopsy, will be found lying in its usual position and may be either normal in shape or distended. The surface has lost its characteristic sheen and has a dull brownish appearance, while the organ itself is obviously swollen. The capillaries coursing over it are congested, and here and there subserous hæmorrhages can be made out. In the presence of frank peritonitis the stomach and adjacent viscera are covered with a milk-white or pale yellow fibrino-purulent exudate. On palpation the organ feels spongy, boggy, rubbery, stiffened or leathery, and when incised its walls will be seen to be from six to nine times thicker than normal.

In the circumscribed type of the disease, when there is so often a localised abscess in the stomach wall, the remainder of the stomach appears healthy, but in the diffuse case the swelling appears to affect the whole viscus and to stop abruptly at the pyloric and œsophageal orifice. According to Pritchard and McRoberts, however, the cellular exudate is found on microscopical examination to extend for a variable distance into the œsophagus and into the duodenum. Although all coats are affected and are infiltrated with pus cells, serum, fibrin and organisms, the main thickening is due to the enormous swelling of the submucosa through which the creamy or cheesy phlegmonous material exudes on section. The mucous membrane is œdematous, mottled by hæmorrhages, velvety in appearance, and covered with tenacious exudate, and when swelling is pronounced the rugæ are thrown into huge longitudinal folds which stretch from one end of the stomach to the other. In the deep troughs which are formed between these folds, purulent matter, tinged with blood, collects, and this, which is teeming with bacteria, reinfects the now more susceptible spongy damaged tissues of the stomach wall.

In the primary or idiopathic case, the mucosa is usually found at autopsy to be intact, although occasionally various degrees of ulceration and even necrosis may be noted. Acute peritonitis which ac-

counts for most of the deaths (70 per cent according to Sundberg) is due to direct extension from the stomach. Associated lesions, the commonest of which are broncho-pneumonia, pleurisy, empyema, pericarditis and meningitis, are usually found in association with the severe pyogenic infections.

SIGNS AND SYMPTOMS

As there are no typical signs and symptoms and as our methods of investigation of the cases are few and unreliable, it is not surprising that the condition is invariably misdiagnosed. A study of the case records, however, will show that the disease can, on the whole, be classified into two main groups: the fulminating toxæmic variety and the less acute "gastric" type.

In the fulminating type of case, the symptoms are those of acute toxæmia, while the signs are those of peritonitis. Vomiting will be a marked feature, the vomited material may be purulent and blood-stained, and may contain shreds of necrotic tissue. The patient will look gravely ill and will feel shivery and exhausted. There will be hyperpyrexia, rapid pulse, dry coated tongue, and epigastric rigidity and tenderness followed in a few days by the symptoms which usually accompany the end of an unsuccessful fight against any severe acute intoxication—extreme prostration, delirium, and then coma.

In the less severe case there is generally a history of a previous gastric disorder, succeeded by the sudden onset of severe epigastric pain which is continuous and which persists or increases in spite of treatment. After a week or so the upper abdomen becomes distended and tenderness is elicited on pressure. Very rarely a localised mass, the thickened stomach, may be made out. When peritonitis supervenes, the guarding on pressure and the tenderness are more universal and extreme, and the patient will then become restless, anxious and dehydrated, and will slowly drift into a state of delirium. In the early stages fever may be absent, but after a while the temperature slowly mounts to 100° F., or may even reach 105° F.

An examination of the blood will in almost every case show a marked polymorphonuclear leucocytosis, ranging from 20,000 to 30,000. Where there is infection with hæmolytic organisms, jaundice may be pronounced.

DIAGNOSIS

The clinical pictures presented by this disease may be indistinguishable from those of acute perforated peptic ulcer, acute hæmorrhagic pancreatitis, fulminating cholecystitis, or hæmatogenous streptococcal or pneumococcal peritonitis.

Are there any available methods of investigation apart from clinical examination of the patient and the routine examination of the blood, of the vomited material, and of the excreta? Watson considers that needle puncture of the upper abdomen with immediate pathological examination of the fluid obtained is an important aid to diagnosis, since, if this is thin, turbid, reddish in colour, and contains large quantities of streptococci, the view that the surgeon is dealing with a case of acute phlegmon of the stomach is supported. Again, Watson and Yngve Olsson (*Acta Radiol.*, 13:134, 1932) have both independently advised the use of X-rays (flat-plate X-rays of the upper abdomen followed by a barium meal) for all those acute abdominal cases where the diagnosis lies between perforated ulcer, acute pancreatitis and gastric phlegmon. In phlegmonous gastritis the most characteristic feature is the combination of a stomach wall grossly thickened throughout and a mucous coat preserved intact, a state of affairs which may on radiological examination sometimes be suggestive of linitis plastica.

TREATMENT

The localised form of the disease, and especially where a circumscribed abscess is found in the stomach wall, should be readily recognised at operation. Additional confirmation may be gained by aspirating pus from the fluctuating or swollen stomach wall at various points. In certain instances simple drainage of the abscess may be indicated and this has been followed by satisfactory results. If, however, the disease is localised to the pyloric segment of the stomach, partial gastrectomy should be performed, a procedure which has been followed by a fair measure of success.

Weinstein and Klein (*Ann. Surg.*, 86:534, 1927) and Hamilton Bailey (*Emergency Surgery*, 3rd ed., 1938) recommend delivering the stomach through the abdominal wound and maintaining it there by

a glass rod as in the Paul Mikulicz operation for cancer of the pelvic colon, after first making a number of small vertical incisions through the seromuscular coats of both walls of the stomach down to the purulent sub-mucosal layer. They suggest draining the lesser sac with a small rubber tube and suturing the upper and lower extremities without unnecessarily constricting the exteriorised stomach. At the completion of this operation a jejunostomy could then be performed through a small separate incision for the purpose of feeding the patient. The prolapsed stomach should be covered with several large hot moist packs, saturated with acriflavine, these being changed at frequent intervals. When progress was satisfactory and the acute inflammatory process in the stomach was evidently subsiding, the glass rod could be removed, allowing the stomach to sink back into the abdominal cavity. So far as I am aware, however, this ingenious operation has never been performed, but on the face of it it would appear to be a sound and logical procedure.

Following any type of operation for this disease, adequate doses of sulphanilamide should be administered together with ample quantities of anti-streptococcal serum, in view of the fact that the responsible organism is usually the streptococcus. Saline, to which glucose may be added, should be given intravenously by the slow drip method and also by the rectal route, as dehydration and toxæmia are always very marked in these cases.

CHAPTER 3

FOREIGN BODIES IN THE STOMACH AND IN THE DUODENUM

Foreign bodies of many varied shapes, sizes, consistencies and origins have from time to time found their way into the stomach or into the duodenum and have been discovered there by various means such as clinical examination, investigation with X-rays, operation, or autopsy.

Foreign bodies in the stomach and in the duodenum may be divided into three major groups:

1. Swallowed foreign bodies.
2. Bezoars.
3. Foreign bodies which have entered the stomach or duodenum through the gastric or duodenal wall.

Swallowed Foreign Bodies. Foreign bodies are either swallowed by *accident* or *intent*. The majority of the patients are children, and most of the foreign bodies ingested are objects which small children should not be permitted to have in their possession. A number of cases are on record of radium needles, which have been used in the treatment of cancer of the tongue or oral pharynx, having slipped from their moorings through vomiting, strenuous efforts at deglutition or during feeding, and having entered the œsophagus have been swept downward into the stomach. When such a mishap occurs the needles should immediately be removed by means of a gastroscope after their position in the stomach has been determined by fluoroscopy.

A number of the patients are also conjurers, neurotics, lunatics or convicts. The latter not infrequently swallow foreign bodies as a means of escaping punishment, while some patients do it out of sheer bravado or to excite sympathy. It would be impossible to enumerate all the foreign bodies which have at one time or another been found in the human stomach or in the duodenum, but pins, needles, safety-pins, tie-pins, badges, emblems, nails, coins, buttons, trinkets, keys, pen nibs, teaspoons, knives, forks and whistles appear

to be the objects chiefly favoured, the commonest being safety-pins and needles. Safety-pins, open or closed, and needles are often swallowed by dressmakers and bootmakers, who acquire a habit of holding these objects in their mouths while working. Another article frequently swallowed is the denture. If large, this may become impacted in the œsophagus. Where an operation is to be undertaken, it is imperative to ascertain that dentures have been removed before any anæsthetic is administered, as these may not only be swallowed but—of greater importance—may enter and obstruct the air-passages with possibly fatal results.

In the majority of cases on record in the literature one object only was swallowed, but there is almost no limit to the number of foreign bodies which a determined person who is hysterical, demented or suicidal may swallow, as has been shown by the following authors: Chalk and Foucar (*Arch. Surg.*, 16:494, 1928), 2,533 various objects; Vandever and Mills (*J. Am. M. Ass.*, 56:180, 1911), 1,446 objects; Winslow (*Ann. Surg.*, 70:60, 1919), nearly 1,300, mostly small; Curl and Culver (*J. Radiol.*, 3:489, 1922), nearly 1,200, including over 1,000 carpet tacks; Matthews (*Calif. State J. M.*, 11:13, 1913), 1,149 hairpins, nails, etc.; Stewart Kennedy (*Brit. M. J.*, 1:1263, 1935), 500 foreign bodies, including 218 screws and nails, many of large size; and Eliason (*J. Am. M. Ass.*, 49:2106, 1917), 452 foreign bodies.

Bezoars. Bezoars are foreign bodies which take on formation after being swallowed, such as hair, persimmons, food particles, vegetable fibres, and specific fluids. They are classified as trichobezoars, phytobezoars, trichophytobezoars, shellac bezoars and rare gastric concretions.

The *trichobezoar*, or hair-ball, is by far the commonest type. These are usually found in young women who become addicted to biting off, chewing and swallowing the ends of their hair. Some of them, however, acquire the habit of cutting off and rolling pieces of hair into small balls which they then swallow. The hair-ball forms very slowly and the production of the large meshy mass which almost completely fills the entire stomach takes many months or even years. A mass similar to the hair-ball may be found in workers in the cotton trade, due to the habit acquired by some of them of frequently swallowing small pieces of cotton which have been bitten off.

The *phytobezoar*, which is often called the food-ball, is composed of vegetable and fruit fibres, skins of fruit, seeds, prunes, celery or persimmons.

The persimmon bezoar is one of extraordinary interest, the first authentic case, according to Rutledge, being reported by Outten in 1894. Rutledge writes:

Since then about 35 cases have been reported in American literature and many in the Japanese, but few, if any, in other countries. This is probably due to the fact that the persimmon is very common in America and Japan and very scarce or not present in other countries. The phytobezoar is formed entirely at one time and is not added to as in the case of the hair-ball or food hair-ball. The food-ball forms very soon after the ingestion of the food and attains its full size at that time. It may remain in the stomach for days, weeks, months or years but never grows larger.

The conditions under which the persimmons are eaten apparently have quite a lot to do with the formation of the bezoar. Careful study of the reported cases shows that the individual ate the fruit in liberal quantities while hungry or fasting and on a practically empty stomach. No other food was taken with the persimmons and no water was drunk at the time of the meal. This type of bezoar is usually seen in the farmer, hunter, golfer or outdoor man who, while on a tramp, and hungry, eats a large quantity of this rather luscious fruit on an empty stomach without drinking water or other fluids. Persimmons have a great gum and pectin content and when eaten on an empty stomach, at the time when the gastric content is rather concentrated with hydrochloric acid, "precipitation" of the pectin and gums is favored, which during their solidification incorporate the fibers, skins and seed causing the formation of the bezoar.¹

The *trichophytobezoar*, or hair-food-ball, is composed of hair mixed with food particles, and like the previous varieties it forms gradually until it attains a large size.

The *shellac bezoar* is composed of shellac which is precipitated in the stomach after the drinking of strong alcoholic solutions of shellac. This is perhaps the rarest type of bezoar and is seen in painters and furniture finishers who use strong solutions of furniture polish which they imbibe as a stimulating beverage.

Rare gastric concretions have been reported after the ingestion of large quantities of bismuth in the treatment of peptic ulcer—bismuth bezoar, while other drugs like salol have likewise formed large solid boluses in the stomach, providing interesting curiosities.

¹ Rutledge, *New Orleans M. & S. J.*, 90 357, 1937.

By far the most comprehensive article on the subject of bezoars and concretions is by DeBakey and Alton Ochsner (*Surg.*, 4:934, 1938), to which those desiring further detailed information on the subject are referred.

Foreign Bodies which have Entered the Stomach or the Duodenum Through the Gastric or the Duodenal Wall. Some foreign bodies enter the stomach or duodenum through wounds produced at operation, or by violence, *e.g.*, gunshot wounds, or from adjacent organs through fistulæ. Cases are known in which certain objects, *e.g.*, hæmostats or swabs which have been inadvertently overlooked, are allowed to remain in the abdominal cavity following operation and have ulcerated their way through the walls of the stomach and become lodged in that viscus. A large gall-stone or many small ones may migrate into the stomach and duodenum, but this can, of course, only occur when a fistula exists between the gall-bladder or common bile duct and the stomach, or between the gall-bladder or common bile duct and the duodenum.

Owing to the anatomical arrangements which exist, it is much commoner for a gall-stone to ulcerate into the duodenum than into the stomach. A large gall-stone may become impacted in the duodenum, but if it negotiates this portion of the gut its passage onward through the small intestine is usually unimpeded until it reaches the narrowest portion of the small intestine, *i.e.*, the lower foot or two of the ileum where such an impaction most frequently occurs.

SIGNS AND SYMPTOMS

Choking, gagging and coughing may be the initial symptoms following the ingestion of a foreign body. On the other hand, the accident may be accompanied by no untoward symptom. Foreign bodies in the stomach do not necessarily give rise to symptoms, and many bodies may be present for some considerable time, remaining unsuspected until discovered by X-ray or at post-mortem examination. This is especially the case in lunatics, the classic example being that recorded by Vandever and Mills who found in the stomach of a lunatic who died of renal disease no fewer than 1,446 bodies including nails of large size, safety-pins, needles, buttons and spoons, which had, nevertheless, given rise to no obvious symptoms during life.

The majority of swallowed objects pass through the pylorus and travel the length of the alimentary canal without mishap, eventually being evacuated with the feces. This statement is confirmed by all writers on the subject, and Clerf (*Surg. Clin. N. Am.*, 86:Feb., 1934), who during a ten-year period attended 834 patients who had foreign bodies in the gastro-intestinal tract who were admitted to the Jefferson Hospital Bronchoscopic Clinic, stated that in 821 of these the foreign bodies passed spontaneously without demonstrable injury to the patient. Of the remaining thirteen, twelve were removed by operation, while in one patient the foreign body, which was an open safety-pin, had become lodged in the sigmoid flexure of the colon and was removed by per-anal endoscopy.

Henderson and Gaston (*Arch. Surg.*, 36:66, 1938) point out that the average time required for foreign bodies to traverse the gastro-intestinal tract is four to five days for blunt objects, five to six days for bodies sharp at one end, and seven days for bodies sharp at both ends. Open safety-pins are usually voided in about four days. These writers consider that if a foreign body has not been recovered from the motions within a week, it is probably firmly lodged somewhere in the gastro-intestinal tract.

If, following the ingestion of a foreign body, symptoms appear, these will of necessity vary according to the size, shape, consistency and position of the object in the stomach or duodenum. Again, there may be symptoms due to associated lesions, such as gastric or duodenal ulceration, gastritis, localised abscess, peritonitis, and so forth. Sharp objects may wound the gastric mucosa and cause extensive ulceration, as Judd and Phillips (1934) and more recently Wheeler (1936) have shown. On the other hand, needles have been known to penetrate the stomach walls and to migrate to various distant parts of the body without giving rise to any symptoms. I have, nevertheless, operated upon two patients where this migration was not attended with such success. In the first instance the needle had penetrated the posterior wall of the stomach, some eight months after having been swallowed, and had tracked downwards sub-peritoneally to the region of the bifurcation of the aorta where it was causing recurrent attacks of abdominal pain, while in the second case a needle had pierced the anterior wall of the stomach and had transfixed the adjacent portion of the transverse colon, producing a

localised abscess. After removal of the foreign-body, both patients recovered.

Sharp objects may become impacted in the anal canal and give rise to an abscess. As stated above, foreign bodies may remain in the stomach without causing symptoms, although the danger of perforation is constantly present, and the longer they remain in the stomach the greater the danger. If perforation does occur, the symptoms differ in no way from those due to perforation of a peptic ulcer with generalised or localised peritonitis. In other cases vague epigastric discomfort, flatulence, and vomiting with sudden bouts of colicky pain due to the object having become wedged in the gut, are complained of by the patient.

A foreign body may occasionally pass out of the stomach, negotiate the curves in the duodenum and become impacted lower down in the intestine, producing symptoms of intestinal obstruction or perforation and peritonitis.

Impaction most frequently occurs in the duodenum, and it is well known that when a foreign body has once passed the duodenum, and particularly the duodeno-jejunal flexure, it will in most instances safely negotiate the remainder of the intestinal tract. Henderson and Gaston reviewed 71 cases of perforation due to ingested foreign bodies and found that the frequency of perforation of the stomach was 36.6 per cent, of the duodenum 13.9 per cent, of the small intestine 16.6 per cent, of the cæcum 15.3 per cent, and of the colon 16.6 per cent.

A hair-ball may be felt as a hard tumour in the epigastrium, painless on palpation and freely movable. It is associated with uneasiness after meals, flatulence, the vomiting of stringy mucus, and a gradual loss of weight due to the difficulty of food percolating through the mass. When it is large it will in some rare cases lead to a diagnosis of carcinoma of the stomach, which may even appear to be confirmed by X-ray examination, the true state of affairs being discovered only at operation. The majority of cases, however, can quite easily be diagnosed correctly nowadays by means of radiology and by the history of the patient having swallowed large quantities of hair.

The symptoms of a phytobezoar are essentially the same as those of gastric ulcer and of acute gastro-enteritis, and will not be further discussed here.

TREATMENT

In all cases the patients should, as a routine measure, first be submitted to X-ray examination in order to confirm that a foreign body has actually been swallowed, and, if present, to determine its position and to gauge the possibility of its passing safely through the intestinal tract without causing injury.

It must here be emphasised that the presence of a foreign body cannot be excluded by negative X-ray findings unless the patient has been examined from the base of the skull to the ischial tuberosities. Failure to appreciate this fact has resulted in many cases of foreign body being overlooked. As the majority of foreign bodies swallowed are opaque to X-rays, it is obvious that the diagnosis can at once be confirmed or negatived by these means. The non-opaque variety is best shown in skiagrams after giving the patient a small quantity of barium or bismuth mixture to swallow. Some of the opaque medium adheres to the foreign body and will often afford definite information as to the size and shape of it as well as its position. Non-opaque foreign bodies of characteristic shape, e.g., non-metallic buttons, can often be recognised by the distribution of the opaque substance over the surface of them. The course of a foreign body through the intestinal tract can be followed by screen examination until it has passed per anum. I once watched the progress through the intestinal tract of a toy lead motor-car, $1\frac{1}{2}$ inches long by $\frac{1}{2}$ inch wide, which had been swallowed by a child aged five years. It went at top speed until it eventually became impacted in the region of the ileocecal valve, a rare place for impaction to occur. It remained stationary here for nearly a week without producing symptoms; then the child complained of pain, and on examination there was a slight degree of abdominal rigidity.

We have here key-notes to two of the reasons for surgical intervention: (1) A persistently lodged foreign body, and (2) a foreign body which causes intractable abdominal pain. The toy motor-car was extracted after disimpacting it from the ileocecal valve and pushing it up into an adjacent coil of ileum where it was removed through a small incision in the gut, this subsequently being closed by a purse-string suture.

When it is proved by fluoroscopy that a foreign body has reached

the colon, the stools should be voided into a chamber containing water, and examined until the object has been passed. Under no condition whatsoever should purgatives be given to aid the expulsion of a foreign body, nor should the patient's diet be changed. It is frequently advised that a diet of soft pulaceous foods should be given to form a kind of cushion around the object and also to protect the mucous membrane from harm; likewise normacol, which produces a jelly-like mass in the intestines, particularly if given in large doses, is believed to enfold a foreign body and carry it along the gut, thus acting as a safe vehicle for it.

Clerf gives his views on this question of diet in such a convincing way that I take the liberty of quoting from him. He writes:

In the matter of diet there are as many opinions as there are advisers. A diet of mashed potatoes, oatmeal or bread and milk is often advised in the belief that these foods will surround the foreign body and bring it safely through. The average progress through the intestinal canal of a foreign body, for example, an open safety-pin, is much slower than that of foods. There is, also, no logical reason why any kind of food should decide to delay its normal progress so that it might accompany the foreign body. Foods in the small intestines are normally in a liquid state and as such would afford remarkably little aid in protecting the intestinal wall from the point of an open safety-pin or in aiding its onward progress. For the same reason it would seem inadvisable to feed a patient on wisps of cotton with the hope and expectation that it would cover sharp points or edges. An additional objection to this method would be the danger of having the cotton entangled with the foreign body and then, preceding it, make traction on an advancing point.²

A large number of foreign bodies can be removed from the stomach by a skilled gastroscopist under fluoroscopic guidance, and Tucker has devised ingenious sheathed flexible gastroscopic forceps for the safe, effective and expeditious extraction of such objects. He considers that

Owing to the fact that air can be insufflated through the forceps, the operator can at all times determine readily the position of the foreign body with relation to the cavity of the stomach, and the stomach folds can be obliterated so that the foreign body can easily be grasped. The instrument should be used by those who are experienced in endoscopic work and intra-esophageal manipulations. Biplane fluoroscopic guidance with the aid of an expert roentgenologist who has developed with the endoscopist a team for the removal of

² Clerf, *Surg. Clin. N. Am.*, 14:Feb., 1951. Courtesy of W. B. Saunders Co.

foreign bodies under fluoroscopic guidance is an indispensable part of the technic. While because of the fact that the patient can be rotated and the position changed with safety under fluoroscopic observation, the method will permit the removal of foreign bodies that would be inaccessible to the ordinary gastroscopic method.³

The indications for surgical intervention may be enumerated as follows:

1. There is impaction of a foreign body; the object is shown to be in the same position after repeated X-ray examinations.
2. There is persistent localised abdominal pain over the site of the foreign body.
3. There are signs of peritonitis, indicating that the foreign body has penetrated the wall of the gut.
4. The object swallowed is very large, very long, or spiky, *e.g.*, a spoon, a large denture with hooks.
5. There is a formidable number of foreign bodies in the stomach, rendering endoscopic removal impracticable.
6. In all cases of bezoar where on account of their composition or size, spontaneous evacuation is unlikely.

Surgical Procedure. The procedure will vary according to the size, shape and position of the foreign body and whether or not operation is advised for a large number of foreign bodies lodged in the stomach or for bezoars. The procedure for a small foreign body, *e.g.*, an open safety-pin, is as follows:

One hour before the patient is transferred to the operating theatre, an X-ray picture is taken to find out the position of the foreign body and to compare its present position with that in previous X-ray pictures. If the foreign body has passed onward and there are no signs of peritonitis, the patient is kept under observation for a further period. If, on the other hand, the foreign body is in the same position as shown by previous X-rays, the abdomen should be explored through a small incision after carefully packing off the abdominal wound and the intestines. If the object is found in the duodenum, it should, if possible, be manipulated back into the stomach, as an incision here is easier and safer to suture than one made in the duodenum, and is unlikely to produce any stenosis. In those cases where the surgeon is unable to palpate the foreign body

³ Tucker, *J. Am. M. Ass.*, 105:1596, 1935.

after the abdomen has been opened, the patient should be returned to the X-ray room, and here, with the aid of the radiologist using a double-plane fluoroscope, the foreign body can be located and grasped within the jaws of a pair of Babcock forceps. The patient is then returned to the operating theatre and the foreign body is removed, its extraction being assisted by manipulation with the fingers which force it against a comparatively avascular portion of the intestinal wall so that it bulges this area. The bulging region is then surrounded by a purse-string suture and the object cut down upon with a knife, pushed through the small aperture in the gut, seized with dissecting or artery forceps, and withdrawn. The purse-string suture is now drawn taut and the inverted portion of the gut reinforced with two or three fine interrupted silk sutures (fig. 11).

The object removed should not touch the surgeon's gloves or any portion of the abdominal wound, as this must be assumed to be contaminated. The abdominal wound is then sutured in the usual way.

This method is applicable to most objects lodged in the gut; for instance, in the case of a coin or spoon the incision may be small, as it can easily be stretched so as to allow of the extraction of such an object with the minimum amount of injury to the intestinal wall. On one occasion I had to remove a Meccano screw-driver which was lodged in the stomach of a child. This was extracted after manipulating the pointed end against the anterior wall of the stomach midway between the greater and lesser curvature. The incision in the gut did not exceed half an inch.

A pin or a needle is simply removed by pushing the pointed end through the wall of the gut, inserting a purse-string suture around the protruding object, seizing it with artery forceps and jerking it outward, after which the purse-string suture is tied. This is well illustrated in figure 11.

In cases in which there is a formidable number of foreign bodies in the stomach, as may occur in the case of a lunatic, the abdomen is explored through a midline incision. When the abdominal wall and the viscera have been carefully protected with cellophane veils, a fairly large incision is made in the longitudinal axis of the stomach, midway between the greater and lesser curvature, a point which is comparatively avascular. After drawing the major portion of the

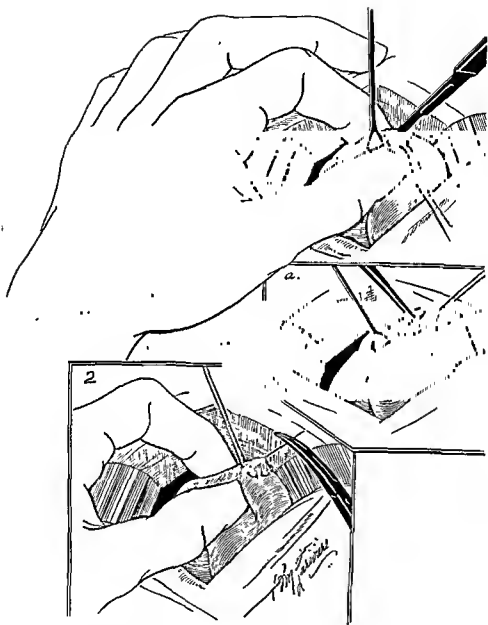


FIG. 11.—METHOD OF EXTRACTING FOREIGN BODIES FROM THE STOMACH OR INTESTINE.

- (1) Withdrawing an open safety-pin from the stomach through a small incision which is surrounded by a purse-string suture.
- (2) Extraction of a pin from the bowel.

stomach through the wound, the incision is carried through the seromuscular layer, and the blood vessels which can be seen coursing in the submucosa are underrun and tied above and below the proposed line of incision through the mucous membrane. The seromuscular layer is partially dissected away from the underlying submucosa and picked up with Allis forceps, after which a small incision is made at one end through which a suction tube can be introduced so that all the fluid in the stomach may be withdrawn. The mucous layer is then slit open for the full length of the incision and held upward with the forceps. A good view is thus obtained of the interior of the stomach. Foreign bodies should be extracted with the greatest care so that no injury may be inflicted upon the mucous lining of the stomach.

When all the objects have been removed, a powerful light, such as a Cameron, is shone into the cavity of the stomach to make sure that no small object has been overlooked. The stomach cavity is then gently mopped out with normal saline solution, after which the mucosa is sutured with a continuous running stitch of No. 1 or No. 0 twenty-day chromic catgut. The edges of the seromuscular layer are approximated in a similar manner, and the suture line is reinforced with a series of closely applied fine silk sutures and further protected with a portion of omentum. A small drainage tube or cigarette drain is led down to the suture line and the abdominal wall is closed in layers.

In the case of bezoars it is well to insert a hand into the stomach after removal of the major portion of the mass, as small fragments may easily be overlooked. In the case of a persimmon bezoar or where the bezoar is thought to be too large for spontaneous evacuation, massage of the stomach, the giving of hydrochloric acid to disintegrate the glutinous mass, and other forms of medical treatment are not advised, and operation should always be undertaken.

It is not uncommon to find a gastric ulcer in association with a large foreign body in the stomach. As these ulcers are of traumatic origin they tend to heal spontaneously when the tumour is removed, and in my opinion no primary operative treatment is therefore warranted.

CHAPTER 4

HYPERTROPHIC PYLORIC STENOSIS OF INFANTS

The incidence of infantile hypertrophic pyloric stenosis is most difficult to determine with accuracy, owing to the widely diverse reports given by various hospitals, but Downes estimates its occurrence as being 1 in every 200 male births, while others place it at 1 in every 200 births regardless of sex. The largest series of cases naturally comes from hospitals for sick children, while the number of admissions to general hospitals is decidedly low, as emphasised by Harris. He writes:

"Cases of congenital hypertrophic pyloric stenosis are still something of a rarity at St. Bartholomew's Hospital. During the last eight-and-a-half years, a period during which all the cases so diagnosed have come under the immediate notice of the writer, there have been thirty-seven cases. The impression has been formed that this is a disproportionately small number. During 1936 there were forty-six cases at the Infants' Hospital."¹

The probable explanation is that general practitioners tend on the whole to send their cases of hypertrophic pyloric stenosis to special hospitals rather than to general hospitals. Romano and McFetridge (*Internat. Surg. Digest*, 25:131, 1938) state that in 1898 Cantley and Dent were able to collect only 17 cases from the literature, but in 1902 they found over 50. Wallace and Wevill (*Brit. M. J.*, 1:1053, 1934) write that from 1922 to 1928 they saw approximately 11 cases each year, whereas from 1928 to 1933 they saw about 26 cases per year. There seems to be little doubt that this increase is due to the condition now being diagnosed more promptly and accurately than previously, and also to an increase in general hospital population and a world-wide greater use of hospital facilities.

The disease is overwhelmingly greater in the male than in the female sex, as is shown in a total of 1,664 cases reported by thirteen different authors. There were 1,462 males (88 per cent) against 202

¹ Harris, *St. Barth. Hosp. Rep.*, 70 43, 1937.

females (12 per cent). Barrington-Ward, in his book *The Abdominal Surgery of Children*, states that of 901 cases admitted to the Great Ormond Street Hospital for Sick Children 86 per cent were males and 15 per cent females; while Jewesbury and Max Page in analysing their figures found that in 301 cases 240 were males and 61 were females. Romano and McFetridge point out that this is greatly out of proportion to the incidence of male and female births and that it is also entirely beyond any reasonable explanation. Still was one of the first to remark on the frequency with which first-born children are affected, Barrington-Ward placing the incidence in his cases at 60 per cent. Wallace and Wevill, by a number of control studies, have shown that this preponderance is real and not merely apparent. More than one infant in a family may be affected. Bilderback (*North-west. Med.*, 27:182, 1928) and others have reported the condition in twins, and Tribble (*J. Am. M. Ass.*, 1:278, 1933) records multiple cases in the same family.

The condition occurs most frequently in breast-fed babies. Thus, in a series presented by Jewesbury and Max Page (*St. Thomas's Hosp. Rep.*, 2:142, 1937) out of 144 cases 80 were wholly breast-fed, 50 were partially breast-fed, and only 14 were bottle-fed.

A large number of theories have been brought forward to explain the cause of infantile hypertrophic pyloric stenosis, but at present there does not seem to be any general agreement on the matter. There are two principal views held to explain the condition: (1) That the pyloric hypertrophy is due to spasm (Thomson), and (2) that there is a primary developmental overgrowth of the circular coat of the pylorus with a consequent reduction in the pyloric lumen (Hirschsprung). The fact that several cases have been reported in which the tumour has been present from birth and even in premature babies (Cautley) would seem to support this view. White (*Am. J. Dis. Child.*, 26:91, 1923) and Cameron (*Brit. M. J.*, 1:815, 1925) consider that these patients are hypertonic and that there is also an autonomic incoordination which leads to contraction of the pyloric sphincter instead of relaxation (achalasia) when food reaches the vestibule of the stomach. This continued incoordination very quickly increases the hypertrophy and causes dilatation of the stomach with consequent retention of food and gastritis. No theory could possibly be acceptable unless it could show why in certain instances there

may be a spontaneous cure and also why there is such an overwhelming majority of male patients.

PATHOLOGICAL ANATOMY

The most striking feature is the pyloric tumour which, as previously stated, is due to an abnormal overgrowth of the circular muscle. The tumour is felt as a tensely hard cartilaginous mass which is olive or barrel-shaped, varying from 1 to 1½ inches in length and from ¾ to 1 inch in diameter. It is interesting to note that in the early cases the tumour is small and pinkish, while in the later stages it becomes whiter and avascular, the peritoneum over it being stretched to the utmost capacity. When the tumour is incised it will grate to the knife, and it will be found that the circular coat of the pylorus is as much as three or four times its normal thickness. The tumour terminates very abruptly at the pyloric outlet and projects into the duodenum as the cervix projects into the vagina. Where the duodenal mucous membrane is reflected on to the tumour a definite fornix is formed and it is at this point that perforation of the duodenum is so likely to occur during pyloromyotomy.

The thickening of the pylorus, although abrupt at the duodenal end, gradually thins out as it is traced into the antrum. When the stomach is opened at autopsy it will be found to be dilated and gastritis a notable feature. In the pyloric region the mucous membrane is crammed into a very narrow space and thrown into longitudinal folds. Wollstein (*Am. J. Dis. Child.*, 22:512, 1922) has shown that after operation healing occurs slowly by contraction of the fibrous tissues of the serous and submucous coats, and that the stomach and pyloric regions return to their normal size in about three months. If the pylorus is carefully examined after this time, only the faintest linear scar will be discernible. The duodenum is normal in every respect.

CLINICAL PICTURE

In most cases the child is healthy and of normal weight at birth. Occasionally, however, it may be below or above normal weight. The first symptoms usually appear between the second and third weeks, although they may start within a few hours of birth or be delayed

until as late as the twelfth to the sixteenth week later. I have known an infant to commence vomiting on the second day after birth; at operation five days later a typical tumour was found and this was treated by pyloromyotomy. In the average case all appears to be progressing satisfactorily until about the second week, when it will be noted that instead of gaining weight the child is actually losing, the bowels are somewhat irregular, and there may be an occasional attack of vomiting. From then onward the symptoms daily become worse, and vomiting, which is always the first and most important of all the symptoms, is a most troublesome feature. In the early stages the vomiting may be described as slight, and occurs after feeding. It will give the mother or the nurse the impression that the child is being overfed or that the wrong diet is being prescribed. With a change in the diet there may be a temporary improvement; but this is soon followed by regurgitation of food, small quantities of mucus-laden opalescent fluid welling up into the mouth from time to time and trickling down the cheeks. Later, larger amounts are vomited at longer intervals, and then the vomiting becomes definitely projectile. The child is seized with a sudden spasm, and a large quantity of fluid is forcibly projected to a great distance through the mouth and nostrils. This type of vomiting is seen in no other condition, with the possible exception of congenital duodenal atresia. In the final stages when the stomach becomes flabby and atonic, projectile vomiting ceases, being replaced by the effortless overflow of gastric contents. There is never any bile in the vomit, although at times blood may be present. The attacks of vomiting are not preceded or accompanied by pain; there is, for instance, no screaming or drawing up of the legs such as is seen in cases of intestinal colic or simple curd indigestion, and the vomiting appears to produce little discomfort. The appetite is always voracious, but seems to diminish just before each attack of vomiting. As soon as the child has voided the contents of the stomach, it will eagerly and keenly take more food.

The bowels, as in most cases of pyloric obstruction, are constipated in fully 90 per cent of cases. In the remaining 10 per cent they may be normal or there may even be diarrhoea. Diarrhoea denotes that infection is present, and this does not differ from other infective diarrhoeas of infancy. The motions are small and green-brown in colour, there being little faecal matter but large quantities of mucus.

As a result of the persistent vomiting there is a rapid loss of weight, and Thompson and Gaisford (*Brit. M. J.*, 2:1037, 1935) affirm that progressive weight loss at an age when weight gain is normally most rapid is in itself a most significant feature of this complaint. As a result of this loss of weight and the dehydration produced by vomiting, the skin becomes dry, thrown into folds and inelastic. In a marked case the face becomes pale or ashen-grey or slightly cyanosed, the brow is furrowed, the nose pinched, the cheek bones prominent, and wrinkles appear around the eyes, the corners of the mouth and the neck, and the child presents the peculiar wizened shriveled mien of a very old person. It should be noted here that the greater the loss of weight the worse the prognosis, as this implies that the disease has been present for some considerable time without having been recognised. Maizels and McArthur (*Lancet*, 1:286, 1930) have shown that in these cases there is always a marked degree of alkalosis and not acidosis. Tetany may appear in late cases, while jaundice of a mild type has been noted in about 1 per cent.

When the abdomen is examined it will be seen that the upper half is bulging and dome-like, while the lower half is empty and flaccid. Visible waves of peristalsis will be observed in every genuine case, sweeping from the left costal margin across the epigastrium to disappear at the outer border of the right rectus muscle. These waves will outline the position of the stomach, and the point where they disappear will indicate the position of the pylorus. It is here therefore that the tumour is to be sought. The visible peristalsis is specially marked after a feeding or after stroking or tickling the skin over the left rectus muscle in its upper half.

The surgeon should have some definite scheme for palpating the abdomen to locate the tumour. The child should be taken from the cot, placed on the nurse's knee, and given a drink of sweetened water. The abdomen is exposed and the knees are slightly drawn up to relax the abdominal wall. The surgeon then places his well-warmed left hand below the right costal margin and gradually presses the fingers in an upward, inward and backward direction, aiming to press the pylorus against the spinal column. He should carefully note the exact point at which the peristaltic waves stop, and search this region very carefully with the tips of his fingers in order to locate the tumour. It may take a considerable time before the tumour is felt,

in fact when the stomach is very full it may be impossible to do so at all. In such cases the stomach should be emptied with a small stomach tube and another attempt be made. If this fails, further palpation is advised when the peristaltic waves are more vigorous.

If all the symptoms point to a diagnosis of infantile pyloric stenosis and if after repeated examinations no tumour is palpable, then the child should be anæsthetised and a final examination conducted. The value of these repeated examinations in a difficult case cannot be too strongly stressed. The more conversant the surgeon is with this disease the more easily palpable will be the tumour, and the later the case the more readily will the mass be felt. The tumour is often described as being acorn-shaped, the size of a small olive, hazelnut in size, as hard as a lymphatic gland, like the tip of a finger, and so forth. It is most readily felt during a severe spasm, and may seem to disappear when the child is quiescent.

Some authorities advise that an X-ray examination of the stomach following the ingestion of a small quantity of barium be used as a routine measure in the diagnosis of these cases; but with this I cannot agree as it is often unnecessary and misleading and it is very difficult to rid the intestinal tract of the opaque medium which may give rise to severe colic, distension and constipation. The examination, too, frequently exhausts the patient and affords very little information beyond the fact that there is delayed emptying of the stomach.

DIAGNOSIS

The diagnosis depends chiefly upon feeling the tumour, as this is found in no other infantile condition. The vomiting, the visible peristalsis, the marked constipation which is usually present, and the palpable tumour, all present such a typical picture that the condition should be most readily recognised. Occasionally pylorospasm may cause some difficulty in diagnosis, but in such cases there is quick response to treatment and a tumour cannot be felt. In congenital duodenal atresia the obstructing agent is present at birth and the infant starts vomiting almost as soon as it is born. Bile is usually found in the vomit, and here again no tumour is palpable.

A barium meal is of considerable help in indicating the site of the obstruction. In gastritis, although there may be frequent attacks of

vomiting in which large quantities of mucus are brought up, the vomiting is never projectile and there is no visible peristalsis. Other features include diarrhoea, poor appetite, and urine which is loaded with chlorides. Internal hernia and volvulus and other such rarities may at times cause confusion in diagnosis.

TREATMENT

In a diagnosed case, Fredet-Ramstedt's operation of pyloromyotomy for relief of the obstruction, followed by a course of medical treatment, is now the generally accepted method of management. Some authorities recommend the adoption of non-operative measures under the following circumstances:

1. When the diagnosis is equivocal: in the absence of a palpable tumour the obstruction is thought to be due to pylorospasm.
2. When the symptoms are not severe and the case may be graded as mild.
3. When the infant is responding satisfactorily to medical therapy and there is an increase in weight.
4. When the initial symptoms have appeared late, *i.e.*, after the tenth week.

Medical treatment entails isolation of the patient, good nursing, careful supervision of the dietary regime, gastric lavage, the giving of saline solutions subcutaneously, and of ample doses of eumydrin. This drug (methyl atropine nitrate) was introduced by Svensgaard (*Arch. Dis. Child.*, 10:443, 1935), who claims that of 61 infants with infantile pyloric stenosis treated by this drug only 2 died, a death-rate of 3.3 per cent. Svensgaard advocates that the routine medical measures outlined above should be supported by giving 2.5 cc. of a freshly prepared 1/10,000 solution of eumydrin by mouth, half an hour before each feed for the first twenty-six days, after which it is gradually reduced and stopped at the end of another fortnight.

In our series of cases eumydrin has not been used sufficiently to form any very definite opinion, but in five hypertrophic cases it failed to relieve the obstruction and these had to be operated on before a cure could be effected. Eumydrin appears to be a useful form of treatment in the spasmodic type and in those cases in which the obstruction is not of a severe character, but the disadvantage in its use is that it necessitates keeping the child in a hospital

ward in an undernourished condition for several weeks and thereby running the risk of cross infection; this risk can of course be diminished by nursing the child in a private room or cubicle when available.²

I make a personal rule of advising operation in all cases where a tumour is palpable beyond any cavil, and since adopting this policy I have had no cause for regret. All patients suspected of having hypertrophic pyloric stenosis but in whom on a repeated examination no tumour could be detected have subsequently responded readily to medical measures, while in only one instance was a needless exploratory operation performed. In this case the infant presented the typical clinical picture associated with the anomaly, and on examination it was thought that a tumour was present. At operation, however, as the pyloric region appeared normal nothing surgical was attempted and the patient eventually made a satisfactory recovery.

The advantages of operative treatment are manifest; the death-rate from the Fredet-Rammstedt operation is very low, and, what is more, it is steadily diminishing; a rapid and permanent cure is effected in the minimum time; the child readily gains in weight and strength and can very soon be placed on a normal diet; furthermore there is considerable economic saving, as, following operation, hospitalisation is reduced to only a few days.

At present it would be fair to assess the operative mortality of hospital cases at approximately 5 per cent and of private cases at from 1 to 2 per cent. This statement is supported by the statistics of the following authorities: David Levi (*Post-Grad. Med. J.*, 414, Oct. 1936) operated upon 50 cases at the Infants' Hospital during the years 1934 and 1935 with only one death; Wakeley (*Modern Treatment in General Practice*, 237, 1935) stated that in the last 120 cases of congenital hypertrophic stenosis of the pylorus which were operated upon by Rammstedt's method at the Kings College Hospital and the Belgrave Hospital for Children there were five deaths only, a mortality of 4.16 per cent, and he considers that this figure could be reduced to nil if children were submitted to operation before they reached the stage of emaciation. Bodley (*J. Tenn. Med. Ass.*, 29:457, 1936) stated that in 60 cases he has had only one death, a mortality of 1.6 per cent. Barrington-Ward writes:

"I have not lost a case in private practice, and indeed I am in-

² Jewesbury and Max Page, *St. Thomas's Hosp. Rep.*, 2:143, 1937.

formed that at the Children's Nursing Home they have had 126 cases without a death." * Ladd (*N. Eng. J. Med.*, 715:215, 1936) found that in a total of 620 cases in the last twenty years the mortality for the first 125 cases was 10 per cent; in the next 495 it was 4.7 per cent, and in this latter group 160 patients were operated upon consecutively without a fatality. Lanman and Mahoney (*Surg., Gynec. & Obst.*, 56:205, 1933) give the following summary of 425 of their cases treated by pyloromyotomy:

SUMMARY OF CASES

Years	Serial No.	No. of Cases	Deaths	Mortality per cent
1915-1923....	1-125	125	13	10.4
1923-1928....	126-275	150	11	7.0
1928-1931....	276-425	150	3	2.0

Kirschner (*Med. Klin.*, 785, June 11, 1937) reported 89 operations for infantile pyloric stenosis with a mortality of 5.6 per cent. Keynes (*St. Barth. Hosp. Rep.*, 70:51, 1937) had 37 cases upon which he operated and all but one survived. In a personal series of 44 cases there were 2 deaths—4.6 per cent.

It is possible for a surgeon to have a large number of early cases in succession with a mortality of under 1 per cent, but it is operation upon delayed cases where there has been a marked loss of weight and inanition that raises the death-rate.

FACTORS WHICH HAVE REDUCED THE OPERATIVE MORTALITY

1. The recognition that early operation is the treatment of choice. The longer the duration of the symptoms and the lower the weight at the time of the operation the higher the mortality. This is indeed a strong plea for early diagnosis and early operation.

2. The adoption of a routine method of pre-operative treatment. This includes:

(a) Careful preparation of the patient for a period of at least forty-eight hours before operation is undertaken. These cases should

* Barrington-Ward, *The Abdominal Surgery of Children*, 2nd ed., 1937, 112.

not be regarded as surgical emergencies and operated upon without due preparation.

(b) Body fluid loss and chemical deficiency are restored by giving small frequent nourishing feedings up to two hours before operation, by the administration of subcutaneous saline solutions and, if necessary, blood transfusion by Marriott and Kekwick's slow-drip method. The small feedings are given every two hours and should be rich in sugars, vitamins and salts. Infusions, which consist of normal saline to which is added 5 per cent glucose, are run very slowly into the pectoral regions, legs and arms until small fluctuating tumours form. From about 120 to 400 cc. is injected daily, but not more than 120 cc. should be given at one time. The nurse should see that the injected fluid is not too hot and that only comparatively small amounts are introduced at one point; otherwise sloughing of the skin may occur with fatal consequences. In desperate cases small quantities of citrated blood should be given intravenously, but always very slowly, not more than 5 to 10 drops being introduced into the circulation per minute. These babies do not tolerate intravenous infusions well, especially if given in too large amounts or too rapidly.

(c) In every case the stomach is aspirated and irrigated with normal saline and not with sodium bicarbonate solution as was formerly practised. The lavage should be performed at least twice a day, and routinely one hour before operation. This reduces gaseous distension, thus rendering operation more simple; it rids the stomach of much mucus and decomposing food; and it tends to cure the gastritis which is always present.

(d) Precautions are taken to prevent loss of body heat before, during and after operation. The operating room should be specially heated to not less than 75° F., and the operating table itself may with advantage be warmed. The child should be dressed in warm woollen clothing which can easily be pulled up but should not be taken off at the time of the operation. Likewise, the limbs should be wrapped in cotton wool and lightly bandaged, only the epigastric region being exposed during the performance of the operation.

(e) The patient should be fast asleep before the operation is started, and this may be ensured by giving chloral, 2½ grs., with nepenthe, 2 minims, one hour beforehand. If an inhalation anæsthetic is to be given, atropine sulphate, 1/200 gr., also is injected

about half an hour before the child is taken to the operating theatre. The child should be carried to the theatre in the arms of the nurse and brought back in a cot.

(f) The choice of anæsthetic is important. Chloroform should never be given owing to its well-known toxic effects upon the liver and to the fact that babies stand this drug badly. Some surgeons consider that the anæsthetic of choice is gas and oxygen, gas-oxygen-ether combination, or open ether. In my last thirty cases I have used only local anæsthesia (0.5 per cent novocaine) and I have been well satisfied with the results obtained. There appears to be less shock, the liability to chest complications is considerably reduced, the surgeon can proceed with the operation more at his leisure, and suture of the abdominal wound is rendered simple owing to the excellent relaxation afforded. The technique of local anæsthesia as employed for these cases will be described later.

(g) The universal acceptance of the Fredet-Rammstedt operation as the technical procedure of choice. The best guarantee of a good and dependable operation for the cure of any condition demanding operative interference is its world-wide acceptance. The popularity of the Fredet-Rammstedt operation for infantile hypertrophic pyloric stenosis has remained unchallenged for over a quarter of a century. Before the advent of this operation the majority of cases were treated medically with a mortality of about 80 per cent. The crude and complicated operation which preceded the Fredet-Rammstedt method had such a damning mortality that the claims of medical therapy were richly strengthened. All these operations lacked the simplicity, the ease and the security of Rammstedt's method. Pylorectomy had a mortality of 100 per cent, the Heineke-Mikulicz procedure was associated with a death-rate of close upon 95 per cent, gastro-jejunostomy certainly not less than 60 per cent, while Loretto's operation of digital or instrumental avulsion of the pyloric tumour was a lethal undertaking except in the very safe and capable hands of Burghard. Fredet (*Rev. de chir.*, 37:208, 1908) obtained better results by longitudinal division of the thickened pylorus, but he prolonged and complicated the operation by transverse suture of the severed friable muscle, which is almost incapable of serving this purpose efficiently. Rammstedt (*Med. Klin.*, 8:1702, 1912; and *Zentralbl. f. Chir.*, 39:1741, 1912), in attempting Fredet's operation upon an emaciated

infant, was unable to complete the transverse suture of the divided pyloric muscular mass owing to the sudden collapse of the patient. He rapidly returned the stomach to the abdominal cavity and hastily inserted a few through-and-through stitches to close the abdominal wall. The child was then returned to the ward in a moribund condition, but to Rammstedt's surprise and gratification a splendid recovery followed and he had the good sense to appreciate the fact that simple longitudinal division of the tumour, allowing full protrusion of the mucous membrane of the pyloric canal, was all that was necessary to effect a cure, and he had the courage of his convictions to repeat this method in subsequent cases with most satisfactory results.

(h) A well-planned scheme of post-operative treatment is essential. All cases are handed over to the care of a pediatrician who supervises the pre- and post-operative treatment. It is the surgeon's duty to relieve the mechanical block which exists by means of an operation which must be safe, simple, expeditious and wholly effective in its immediate and late results. The Fredet-Rammstedt operation ably fulfils all these requirements.

The operation should be regarded as an incident, although a most important one, in the treatment. The services of a good nurse, who has had previous experience in the management of such cases, is indispensable. Success will in no small measure depend upon her skill, unremitting attention and cleanliness, and it is desirable, in fact essential, that she should devote her whole time to the one case under her care. It has been noted by all authors that private patients fare better in every respect than hospital patients, and this especially applies to Great Britain where private patients are undoubtedly diagnosed earlier and treated more promptly than hospital patients. This point has received special emphasis from Herzfeld and Wallace (*Lancet*, 2:385, 1935), who rightly maintain that it is the long delay which so frequently occurs in diagnosing cases of the hospital class which is so disastrous.

There are numerous formulæ devised for post-operative feeding, many of which will be found to be reliable; but the one which I have employed with complete satisfaction for my patients for more than ten years, with perhaps certain modifications for specific cases, is that recommended by Poynton, Higgins and Brydson (*Lancet*, 206:215, 1924).

SCHEME OF FEEDING AFTER OPERATION

(A) *Breast Feeding*

Operation 10.30 A.M., return to ward 11 A.M.; milk drawn from mother four hours later.

First day. 3 to 8 P.M. 1 dr. hourly.

9 to 10 P.M. 2 dr.

11 and 12 P.M. 3 dr.

Second day. 1 and 2 A.M. 3 dr.

3 and 5 A.M. 4 dr.

7 and 9 A.M. 6 dr.

11 A.M., 1 P.M., and 3 P.M. 1 dr.

To breast for three minutes, time varies.

5 P.M. $1\frac{1}{2}$ oz.

To breast for five to seven minutes.

7.30 P.M. $1\frac{1}{2}$ oz.

Continue two-and-a-half-hourly for 12 hours.

Third day. 7.30 A.M. (three-hourly for 12 hours).

Breast five to seven minutes.

7.30 P.M. (three-hourly).

Breast for a quarter-hour or twenty minutes.

A record is made on charts of these babies' weights during the first few days.

(B) *Bottle Feeding*

A reliable skimmed dried milk is used, or the following: Cow's milk 2 oz.; lactose 1 dr.; water 1 oz.; peptonised for $2\frac{1}{2}$ hours. Operation 10.30 A.M., return to ward 11 A.M.; four hours after commence feeding.

First day. 3 to 8 P.M. 1 dr. hourly.

9 and 10 P.M. 2 drs.

11 P.M. to 1 A.M. 3 drs. hourly.

Second day. 2 A.M. 3 drs.

3 and 5 A.M. 4 drs.

7 and 9 A.M. 6 drs.

11 A.M., 1 P.M., and 3 P.M. 1 oz.

5 and 7.30 P.M. 1 oz.

Continue two-and-a-half-hourly for 12 hours.

Third day. Dried milk (half cream) 1 dr. to 1 oz.

7.30 A.M. $1\frac{1}{2}$ oz. three-hourly for 12 hours.

7.30 P.M. 2 oz. three-hourly.

Increase to $2\frac{1}{2}$ oz. or 3 oz. according to age.

The immediate post-operative treatment consists of slightly raising the foot of the bed, applying an electrically-heated blanket, and giving the patient a rectal infusion of normal saline solution, 2 oz., which contains glucose 2 drs. and brandy 1 dr. As the baby should not be allowed to become overheated, it is well to remove the wool from the extremities and to dispense with hot water bottles, heated blankets, etc., as soon as normal body temperature is stabilised.

THE FREDET-RAHMSTEDT OPERATION

The upper and lower limbs are wrapped in cotton wool and lightly swathed, and the child is then bandaged to a wooden cross which is well padded with soft spongy rubber. A small air-cushion or sand-bag is placed under the lower ribs to throw the epigastric region forward and to render the pyloric region more accessible. The upper half of the abdomen and the lower part of the chest are painted with warm merthiolate solution, after which the local anæsthetic is introduced. Using a very fine needle attached to a 20 cc. Record syringe which has been filled with 0.5 novocaine to which no adrenalin is added, four tiny wheals are raised in the skin at the outer borders of the upper halves of the rectus muscles, one on each side in a line with the umbilicus and one on each side close to the tips of the ninth costal cartilages. Through the lower wheals the subcutaneous tissues at the outer borders of the rectus muscles are infiltrated in an upward direction until the costal margins are reached. When this has been completed, the aponeurotic and muscular tissues in these regions are likewise injected with a small quantity of the solution. Through the upper wheals the fluid is forced toward the xiphisternum and then the muscular bellies of the rectus muscles are freely infiltrated from their outer to their inner borders. In this way the sensory and motor nerves over a large area of the epigastrium are completely blocked and the incision through the abdominal wall can be made in tissue which is not sodden with a watery local anæsthetic solution. This is better than infiltrating the tissues in the proposed line of the abdominal incision, as sepsis and other complications of the wound are less likely to occur when the field-block method is used. After the local anæsthetic has been injected, the surgeon should wait fully ten minutes to allow of its taking full effect, and after the skin incision

has been made and the rectus muscle is divided or drawn aside, the underlying white shiny peritoneum should be anæsthetised with a few drops of a local anæsthetic before it is incised.

As soon as the peritoneum is divided for the full length of the incision, it is picked up on each side and the under-surface is exposed by using small hook retractors. The parietal peritoneum and the tissues anterior to this, which are so richly supplied with sensory nerves, then receive a generous dose of the local anæsthetic solution, the needle being inserted at several points and thrust from within outward. A small strip of gauze which has been soaked in the novocaine solution is then gently placed underneath the liver, close to the pyloric region, and allowed to remain there for a few minutes before proceeding with the next stage of the operation, with the object of anæsthetising the gastrohepatic omentum. If this method is employed it is possible to obtain complete relaxation and to occasion the child little or no pain, even when the stomach is drawn through the wound or the incision is being sutured.

There is a choice of many incisions, some of which are vertical and others oblique or transverse. Vertical incisions include the mid-line, the paramedian and the transrectus or muscle-split incisions (fig. 12). The last mentioned is the favourite, as it is very easy to make and can be rapidly closed. The oblique or transverse incision is made boldly about one finger-breadth below the costal margin, through the body of the right rectus muscle. It affords excellent exposure and decreases the likelihood of any extrusion of the omentum, colon or small intestine if the child strains or cries during the operation. Again, being transversely placed, there is very little tension and the suturing of such an incision is consequently a simple matter.

There are two essentials to all these incisions: They must be small, not exceeding 2 inches, and they must be placed high up in the epigastrium over the liver.

Just before the peritoneum is incised, tetracloths are affixed to the skin margins with Michel clips. The peritoneum itself must be very carefully picked up before incising it, as it is so easy inadvertently to wound the underlying liver. The liver should be hooked upward with the left index finger, and the pyloric region of the stomach grasped with non-toothed dissecting forceps and coaxed into the

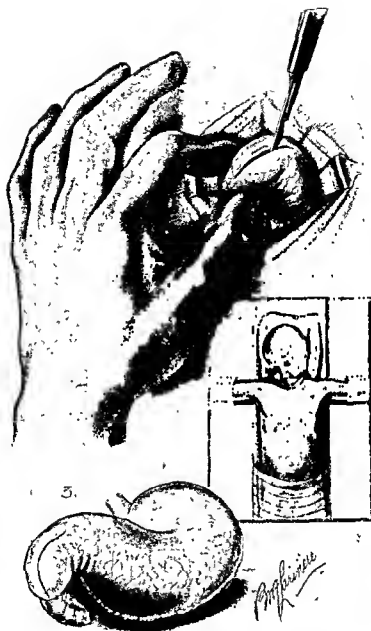


FIG. 12.—THE FREDET-RAMSTEDT OPERATION OF PYLOROMYOTOMY.

- (1) Method of steadying the pyloric tumour and of making the incision through the seromuscular layer.
- (2) Showing the position of the child on the operating table and the choice of incision—vertical or subcostal.
- (3) Lines of incision as suggested by Wolfson.

wound, aided by gentle manipulation with the fingers. The pyloric tumour should then be fixed with the thumb and index finger of the left hand, the tips being placed underneath the tumour and adjacent duodenum to prevent the tumour from slipping back into the abdomen (see fig. 12). It is then firmly gripped and rotated slightly to the left so that the anterior aspect of the tumour, the commencement of the duodenum and the antrum are clearly visible. The remaining portion of the stomach, which may bulge into the wound, is covered with a warm pack which has been soaked in saline solution.

A longitudinal incision should then be made in the hypertrophied area at the junction of the middle and upper thirds of the anterior aspect where the blood vessels seem to be scarce (see fig. 12). This incision is slightly curved with its concavity downward, starting just proximal to the pyloric vein of Mayo which indicates the gastro-duodenal junction, and being carried through the peritoneal and superficial muscular coats over the pyloric tumour and a little beyond it upward into the body of the stomach. Using the handle of the knife, the muscle fibres are widely separated throughout the length of the incision until the glistening white mucous membrane is visible and eventually bulges through the gap (fig. 13). A little gentle stretching of the fibres with a haemostat, as is well shown in figure 13 and a little cautious dissection here and there may be necessary to make absolutely sure that all constricting fibres, and particularly those close to the gastro-duodenal junction have been severed and that an efficient patency is ensured. This part of the dissection is simple, as the thickened circular coat rapidly springs apart, producing an oval wound in the pyloric region of the stomach, the base of which is formed by the tough mucous membrane of the pyloric canal.

Wolfson (*Ann. Surg.*, 101:965, 1935) has slightly modified this procedure by making a small vertical incision, 0.5 cm. in length, proximal and parallel to the vein of Mayo through the serosa and the superficial muscle fibres. A second longitudinal incision is then made over the pyloric tumour and is directed downward to meet the midpoint of the vertical incision (see figure 12 [3]). After widely separating the edges of these incisions by blunt dissection, the mucous membrane will freely protrude through this relatively large triangular gap in the muscle.

As soon as the patency of the pylorus has been assured, a hot com-

press is firmly applied to the cut surface in the gut to arrest any oozing, which is, however, usually trivial. If bleeding persists from any point, this area should be underrun with a fine atraumatic needle and tied off with catgut.

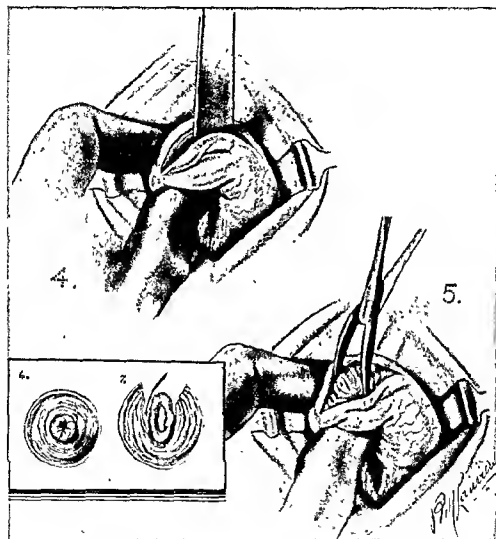


FIG. 13.—THE FREDET-RAMSTEDT OPERATION OF PYLOROMYOTOMY.

- (4) The thickened muscles of the pyloric region are being separated with the handle of a knife.
- (5) The mucous membrane is made to gape widely into the wound through the incision in the pylorus.
- (6) Transverse section of the pyloric tumour.
- (7) The dilated pyloric canal after division of the muscle fibres.

It is always a wise precaution to make sure that the duodenum has not been punctured at the fornix. In most cases such a mishap is immediately recognised by the escape of a few drop of glary, bile-stained fluid, while in others, by compressing the body of the stomach, air can be forced into the duodenum and if a small perforation exists this can be detected by the hiss of air through the aperture. Such perforations should be sutured immediately with fine catgut and the area protected with a wisp of omentum. This added precaution does not in any way detract from the completeness or the success of the operation. If the puncture is not recognised at the time of the operation, general peritonitis will, of course, develop. When therefore the surgeon has made quite sure that the pyloric outlet is widely patent, that there is no bleeding, and that no perforation of the duodenal mucous membrane exists, the stomach is returned to the abdominal cavity and the wound sutured in layers of No. 0 chromic catgut, the skin edges being approximated with Michel clips, after which the wound is again painted with warm merthiolate solution and an ample gauze dressing firmly strapped into position with adhesive plaster. The dressing is not disturbed until the fifth or sixth day, when the clips are removed and a fresh dressing is applied, after which the child is sent home, provided progress is satisfactory.

Post-Operative Complications. These, as Thompson and Gaisford suggest, are best classified into two main groups:

1. *Surgical:* (a) Wound sepsis; (b) dehiscence; (c) incisional hernia; (d) incomplete operation; (e) hæmorrhage; (f) peritonitis, and (g) post-operative collapse.

2. *Medical:* (a) Gastro-enteritis; (b) hyperpyrexia; (c) acute otitis media; (d) pyelonephritis; (e) broncho-pneumonia, and (d) "ward infection."

Wound sepsis, stitch abscess, dehiscence of the wound and ventral hernia occur in a small but sufficiently significant number of cases to imply that modern operative technique is not always impeccable. An incomplete operation, which is due to inadequate division of the constricting pyloric muscular fibres, especially near the dangerous "fornix," blatantly declares itself by the return of stubborn projectile vomiting. The surgeon should be quick to realise the true state of affairs and not lull himself into the belief that the vomiting is due to post-anæsthetic sickness. He must act promptly: the abdomen must

be re-opened, and after drawing the pylorus through the wound the constricting fibres concerned must be freely but cautiously severed. Intra-peritoneal hæmorrhage and peritonitis are avoided by attention to the details of operative technique as already outlined.

Post-operative collapse is often attributable to shock or to collapse of the lung, and may be obviated by the use of local in preference to general anæsthesia.

Gastro-enteritis or enteritis is by far the most dreaded post-operative complication and is the commonest cause of death. Its onset may be delayed until the second post-operative week, but it may occur at a later date when the child appears to be making steady progress. Following a brief period of mild pyrexia, vomiting and occasional attacks of colicky pain, the temperature suddenly soars and at the same time small watery evil-smelling stools are passed with distressing frequency. Hyperpyrexia is not necessarily an outcome of the operation, since it has been observed prior to it. It is, in all probability, secondary to an enteritis. Response to the usual well-tried remedies is often tardy or absent, and in cases where the diarrhoea proves incoercible after forty-eight hours of assiduous treatment, a fatal issue is almost inevitable. Immediate recourse to blood transfusion will, however, in certain instances prove a life-saving measure.

Enteritis can frequently be prevented by giving the patient sterile digestible feedings in carefully regulated quantities and at specified intervals.

CHAPTER 5

GASTRIC AND DUODENAL DIVERTICULA

These are rounded, pouch-shaped or sac-like protrusions from the gut, and include *true* diverticula (congenital and acquired), and *false* diverticula which result from intrinsic lesions of the gastric or duodenal wall, such as peptic ulcer or malignant disease.

Gastric and duodenal diverticula should no longer be regarded as surgical or pathological oddities, since, owing to world-wide improvement in diagnostic methods, and especially in radiology, to a more scrupulous performance of autopsies, and a more painstaking and searching scrutiny of the viscera as displayed at exploratory operation, it has been proved that they occur more frequently than was formerly supposed and must now be reckoned in the differential diagnosis of upper abdominal diseases.

Ian Fraser (*Brit. J. Surg.*, 2:183, 1933) states that diverticula occur in different parts of the alimentary tract in the following order of frequency: colon, rectum, duodenum, pharynx and œsophagus, stomach and jejuno-ileum. Larimore and Graham (*Surg., Gynec. & Obst.*, 45:257, 1927), in a series of 3,446 examinations of the digestive tract with the opaque meal, found 105 diverticula. Of these, 71 were in the colon, 19 in the duodenum, 9 in the œsophagus, 3 in the stomach, and 3 in the jejunum. These statistics are therefore closely in accord with those given by Ian Fraser.

Although gastric and duodenal diverticula have certain features in common, it is here deemed preferable to discuss them separately.

GASTRIC DIVERTICULA

On Voigtel's authority, it is frequently stated in papers relating to gastric diverticula that Helmont was the first to report this condition; but the claim of any individual to priority in recording any known pathological lesion or in performing any surgical procedure is always most difficult to establish and can rarely be placed beyond dispute.

For instance, while Helmont (1804) is credited with being the first to describe a diverticulum of the stomach, I find that Thomas Baillie (1793) has given an accurate account of this very abnormality. He writes:

A part of the stomach is occasionally formed into a pouch by mechanical means, although very rarely. I have seen one instance of a pouch being so formed, in which five halfpence had been lodged. The coats of the stomach were thinner at that part, but were not inflamed or ulcerated. The halfpence had remained there for some considerable time, forming a pouch by their pressure, but had not irritated the stomach in such a manner as to produce inflammation or ulceration.¹

Ætiology. Ewart and Cordiner (*Brit. J. Surg.*, 23:530, 1936), in a series of 370 consecutive opaque meal examinations, found a gastric diverticulum in 11 cases. Rivers, Stevens and Kirklin (*Surg. Gynec. & Obst.*, 60:106, 1935), after a searching investigation, could find only 141 recorded cases in the literature up to 1935. Since then these figures have been considerably augmented and there is now a wealth of material from which some accurate observations on the subject may be made.

It has been the habit of most observers to state that gastric diverticula are most commonly seen in women; but in point of fact there appears to be little difference in the sex incidence in 103 cases analysed by Lay Martin (*Ann. Int. Med.*, 10:455, 1936) since 54 of these were women.

These diverticula have been found at all ages. Broman and Pernkopf each found one in a fetus, and Sinclair (*Brit. M. J.*, 18:182, 1929) reported a case of a four months' old child upon whom he successfully operated for a congenital diverticulum.

Rivers, Stevens and Kirklin, of the Mayo Clinic, consider that there is much confusion and inaccuracy in the classification of gastric diverticula, and in order to simplify the subject they have suggested the following subdivisions:

(1) *True Diverticula.* Those in which the pouch includes all coats of the gastric wall without definite evidence that organic disease was the causative factor. Such diverticula probably are congenital.

(2) *Acquired, True Diverticula.* In these, all coats of the gastric wall are

¹Thomas Baillie, *The Morbid Anatomy of Some of the Most Important Parts of the Human Body*, 1793, Chap. 7, p. 92.

present although there may be some thinning, and there is evidence that some disease was instrumental in causing the pouching.

(a) Pulsion type diverticula result from intragastric pressure which is probably localised.

(b) Traction type diverticula are incidental to extra-gastric adhesions.

(3) *False Diverticula or Diverticular Formations*. In these there is a break in the gastric wall resulting from disease.²

Pathology. All observers are agreed that true congenital diverticula, which are composed of all the coats of the stomach, are very rare. It is therefore the acquired type, which occurs chiefly between the ages of forty and sixty, which represents the majority.

The cause of these hernial protrusions is not always clear. It is probable that one of the most important pre-disposing factors is the presence of a localised congenital weakness or anatomical defect in the muscular coat of the stomach, such as is prone to occur in the region of the cardia and at the pylorus. Normally, the muscular coats along the lesser and greater curvature close to the œsophageal opening are thinned out and widely spaced, and it is here that these pouchings are so frequently seen on X-ray examination. In the traction type the ætiology is clear: A small portion of the stomach is drawn outward into a funnel-shaped structure by strong contracting adhesions which bind it to the gall-bladder, the pancreas, the spleen, the colon or the abdominal wall. Ewart and Cordiner consider that, among other factors, pulsion is the most important. A herniation of the mucons and submucons coats takes place at the congenitally or anatomically weakened site as the outcome of the recurrent increases in intra-gastric pressure. Once the protrusion has occurred it gradually enlarges in consequence of the repeated filling and distension which results from the intake of food. This distension leads to a thinning of all the coats of the diverticulum. Diverticula which occur at the sites where previous gastric ulcers have been excised are probably of this nature. The acquired false type of diverticula is due to a weakening of the stomach wall by inflammation, by peptic ulceration, or by cancerous invasion, aided and abetted by intra-gastric pressure.

Gastric diverticula occur most often in the region of the cardia close to the œsophageal opening on the lesser curvature (fig. 14).

² Rivers, Stevens and Kirklin, *Surg. Gynec. & Obst.*, 60:106, 1935.

Next in order of frequency they are found in the fundus, the pylorus, and on the posterior wall of the antrum.

As might well be expected, they vary in size and shape. They may be small as a pea or large as a closed fist, and appear either as finger-like or pear-shaped protrusions. The diameter of the opening also varies considerably, and may be large enough to admit one or more fingers, or be so attenuated as to allow the introduction of only



FIG. 14.—GASTRIC DIVERTICULUM (BULL).

the finest probe. The actual size of the opening is important since, when large, the gastric contents can freely enter and leave the pouch without producing any stagnation; when small, however, it may easily be missed on screening through the inability of the opaque substance to enter the sac. Again, retention of food with subsequent decomposition and inflammatory change is prone to take place when the stalk is narrow. The following complications may accompany the condition: Diverticulitis, peri-diverticulitis, gangrene, perforation.

hæmorrhage and malignant transformation; but these are all of rare occurrence.

Signs and Symptoms. True diverticula may cause no symptoms, although in some instances failure of the pouch to empty normally during digestion has been responsible for epigastric uneasiness, flatulent dyspepsia, and gnawing pain. In some cases the local stasis is followed by diverticulitis or peri-diverticulitis, and when this occurs the pain is accentuated. Hæmorrhage from the interior of a diverticulum has also been reported by several authors. On the other hand, it must be remembered that, as Payne (*Brit. M. J.*, 2:968, 1936) remarks, associated gastric or duodenal disease in the form of ulceration has been present in many of the recorded cases, accounting for the symptoms present.

Diagnosis. There is no typical clinical picture of gastric diverticula, and the condition can only be diagnosed in the living person by means of radiology, gastroscopy or at operation. It is surprising how frequently the lesion is overlooked during the conduct of an exploratory laparotomy. Today the main reliance is placed upon screening after the ingestion of an opaque meal, but even the expert radiologist will on occasion have great difficulty in interpreting his findings, as has been proved by Kirklin. Akerlund (*Acta. Radiol.*, 2:476, 1923) was one of the first to describe the radiological appearances of gastric diverticula, especially the type which sometimes occurs in the cardia as a circumscribed, smooth, evenly-rounded projection from the gastric lumen, in which the barium pools at the bottom of the sac and a bubble appears above when the patient is placed in the erect position (see fig. 14). Cordiner states that diverticula arising from the anterior or posterior wall may easily be overlooked if the examination is only carried out with the patient in the erect position and with distended filling of the stomach. By using Berg's mucosal relief technique and by examining the patient in all positions between the extreme Trendelenburg and the erect, the diverticulum can be projected clear of the stomach and its stalk and point of origin determined. Cordiner also considers that the presence of longitudinal folds in the sac itself is pathognomonic of a diverticulum. The most common fault is to mistake a diverticulum for a large penetrating gastric ulcer. Diverticula, however, usually occur in those portions of the stomach where ulcers are rarely seen, *i.e.*, in the cardia, in the fundus,

along the greater curvature, etc., and there is in addition absence of the spasm and of the convergence of the mucosal folds frequently seen in association with ulcer.

Treatment. As in the majority of cases the condition gives rise to few if any symptoms, surgical interference would appear to be rarely indicated. The mere proof that a diverticulum exists is not in itself a plea for its immediate excision. If it is causing no distress and is not associated with any concomitant gastric or other abdominal lesion, it is well to leave it alone. For those cases in which there are mild symptoms, medical treatment is advised, and this consists in giving the patient a bland, non-residue diet and an alkaline mixture containing bismuth and belladonna three times a day after meals, and by the adoption of postural treatment. It is unlikely, however, that such measures, even when carried out with care and discrimination, are likely to afford the patient much permanent relief. Operation is advised under the following conditions:

1. When the symptoms are severe and there is no relief obtained after a careful course of medical treatment.
2. When complications such as hæmorrhage have occurred.
3. When the diagnosis is uncertain and the presence of malignant disease cannot be excluded.
4. When there is an associated lesion present, *e.g.*, gastric ulcer.
5. In all cases where a diverticulum has been demonstrated in the pyloric region of the stomach.
6. Where the pedicle is narrow but the fundus is unduly wide; in such instances the onset of diverticulitis may be predicted with certainty.

The actual operative procedure will depend upon the position and size of the diverticulum, the calibre of the stalk, whether or not secondary changes have occurred, and the presence of associated lesions. If a diverticulum has a narrow stalk, this should be freed and clamped, and after cutting away the sac the stalk should be tied and infolded into the stomach, after which the infolded area should be reinforced with a few silk sutures and an adjacent tag of fat. In the globular type of sac with a wide neck, after mobilisation has been completed, the diverticulum is freely excised and the gastric wall breach is carefully repaired. It should be remembered that the stomach wall at the base of the diverticulum is weak and should therefore be well

infolded. If secondary changes are noted, such as ulcer or malignant growth, a wide area of the stomach wall should be sacrificed.

When the anomaly occurs in the pyloric region, pylorectomy would appear to be the operation of choice, while in every case in which there are associated gastric or duodenal lesions the surgical procedure will have to be modified according to the type of disease present.

In all cases where excision is indicated it is most imperative to obtain a good inversion of the gastric wall, as to leave any weakness here would predispose to a recurrence of the condition.

The results of operative treatment in cases where the symptoms have been severe are, on the whole, satisfactory, as 80 per cent of permanent cures are reported from various clinics.

DUODENAL DIVERTICULA

Chomel (1710) is given the credit of recording the first case of duodenal diverticulum. He found in a woman of eighty, who died from an apoplectic fit, a duodenal pouch containing 22 gall-stones. It would seem likely, however, that the pouch was in fact a dilated ampulla of Vater! Authentic cases were later reported by Morgagni (1765) and by Sommering (1794). The abnormality was first observed by X-ray examination in 1912, and in the following year Bauer performed a gastro-jejunostomy for a duodenal diverticulum which was producing obstructive symptoms. Forssell and Key (1915) were the first to excise a duodenal diverticulum which had been diagnosed by radiography. Ritchie and McWhorter (*Journal-Lancet*, 37:361, 1917) reviewed the literature and found that up to 1917 only 76 authentic cases had been reported. The clinical significance of the condition was ably brought to the notice of the profession by W. J. Mayo, Moynihan, Beer, Wilkie, Kellogg and Drummond.

Ætiology. It is difficult to assess the true incidence of duodenal diverticulum with any accuracy, but the autopsy reports recorded by Odgers (*Brit. J. Surg.*, 18:592, 1930) give percentages which are similar to the series submitted by radiologists. Harold Edwards found 22 cases in 2,247 X-ray examinations (1 per cent), and this closely compares with Andrews' series of 26 cases in 220 examinations. In Spriggs and Marxer's first series only 10 cases were found in 1,000

barium meal investigations (1 per cent). Case (*J. Am. M. Ass.*, 75:1463, 1920) reported 85 cases in 6,847 routine X-ray examinations (1.24 per cent). Spriggs and Marxer (*Quart. J. Med.*, 1:19, 1925), however, in a second series diagnosed 38 cases in 1,000 X-ray films (3.8 per cent), while Cryderman found 45 cases in 770 X-ray examinations (5.85 per cent). These figures apparently do not take into account the false diverticula of the first portion of the duodenum which are due in the majority of instances to peptic ulceration. If they did so, the incidence, as determined by radiology, would be considerably higher.

Nagel (*Arch. Surg.*, 11:529, 1925), in investigating the post-mortem records of over 900 cases found a 2.2 per cent incidence, while Odgers states that Linsmayer's statistics showed 3.3 per cent and Baldwin and Grant's were as high as 16 per cent.

Duodenal diverticula are rare before the age of thirty and uncommon before forty, their incidence rapidly rising after the age of fifty. Beals (*South. M. J.*, 30:218, 1937) reported a series of 34 patients, the average age being 53.3 years. This conforms to the figures given by Edwards (51.9) and Cryderman (51.7). The condition is commoner in females than in males, as evidenced by Edwards who, on analysing 263 cases found in the literature in which sex is mentioned, assesses the distribution between the sexes as follows: males 112 and females 151.

Classification. 1. *True Congenital Diverticula.* These are present from birth and are identical with the structure of the duodenum from which they arise.

2. *Primary Diverticula.* These are acquired hernial protrusions of certain layers of the duodenum, i.e., mucosa, muscularis mucosae, and submucosa, through a localised weakened area in the gut wall. This weakened area may be due to congenital or anatomical causes. The true muscular coat of these diverticula is either absent or grossly deficient.

3. *Secondary Diverticula.* These are sometimes termed false diverticula and are due to peptic ulcer or to traction. Those due to peptic duodenal ulceration are almost invariably found in the first portion of the duodenum. The traction diverticulum is caused by contracting scar tissue which is adherent to the wall of the gut. A good example of this type is furnished by certain cases of cholecystitis in which the

gall-bladder becomes adherent to the first or second part of the duodenum, and when fibrotic shrinkage occurs a small pouch of duodenum is pulled out by the retracting gall-bladder.

Pathological Anatomy. Duodenal diverticula may be solitary or multiple. The solitary type is much in preponderance, 80 per cent according to Kellogg. The primary type never springs from the first portion of the duodenum. This is the prerogative of the ulcer type,



FIG. 15.—DUODENAL DIVERTICULUM.

The stalk springing from the infero-lateral aspect of the commencement of the third part of the duodenum (Calthrop).

and while many are found in the third or fourth portion, from 62 to 83 per cent are seen in the second part (figs. 15 and 16). The majority are retroperitoneal and are situated on the concave inner aspect near the inferior border of the descending limb of the second portion of the duodenum, always in close proximity to the common bile and pancreatic ducts, with their openings into the gut close to the papilla and with their flask-shaped, thin-walled bodies abut-

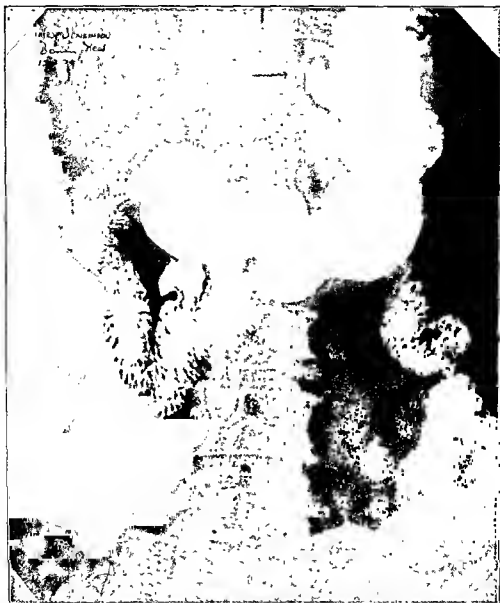


FIG. 16.—TWO DIVERTICULA OF THE THIRD PART OF THE DUODENUM.

There is also a fairly large gastric diverticulum high up on the lesser curvature of the stomach (Bull).

ting upon or even penetrating the pancreas (fig. 17). The primary diverticula are rightly regarded as hernial protrusions of the duodenal wall, and the close relationship of their pedicles to the blood vessels which pierce the inner concave aspect of the bowel or to the



FIG. 17.—DUODENAL DIVERTICULUM OF THE SECOND PART OF THE DUODENUM.

The neck of the sac was shown at operation to be lying in close proximity to the common bile and pancreatic ducts (Bull).

entry of the common bile duct suggests a gradually developing protrusion through a weak spot thus formed. Fletcher and Castleden write:

Their structure is frail: when dissected out from the areolar tissue which surrounds them they are collapsed, thin-walled, and consist of the mucous and submucous coats of the intestine with perhaps a few muscle fibres gradually fading away as the flask-shaped fundus is reached. Their opening into the bowel varies in size and may be large enough to admit the tip of a finger. There would seem, therefore, to be little hindrance to the entrance and exit of chyme, though the deficiency of muscle fibre in the wall would favour stasis within the sac.⁹

⁹ Fletcher and Castleden, *Brit. J. Surg.*, 23:776, 1936.

MacLean (*Surg. Gynec. & Obst.*, 37:6, 1923) considers that the primary pathological changes which take place in a duodenal diverticulum do not differ from those in the mucosa of any other part of the alimentary tract. Briefly, these changes may be catarrhal, ulcerative, suppurative, perforative, or malignant, but each and all are rare.

Cases have been reported of cancer primarily involving a diverticulum, and of pancreatitis and cholangitis occurring from spread of infection from an inflamed pouch.

Apart, however, from these rarities, the vast majority of pouches removed by operation or post-mortem, when examined microscopically, show no trace of inflammation past or present, and it is hardly surprising to find scepticism as to whether an uninflamed diverticulum *can* give rise to clinical symptoms. Probably it seldom does. Nevertheless, instances occasionally occur in which it would appear to do so.*

Signs and Symptoms. There are no pathognomonic signs or symptoms of a duodenal diverticulum, and a diagnosis cannot be made solely upon clinical evidence. A diverticulum may be present and show no noticeable ill-effects. When symptoms are present for any period of time they are often indistinguishable from those produced by peptic ulcer, cholecystitis, or pancreatitis, and are in all probability due to pylorospasm, to distension of the pouch, to pressure effects, or to inflammation of the diverticulum or adjacent structures such as the pancreas or common bile duct. In those exceptional instances in which a diverticular process becomes acutely inflamed, the signs and symptoms will resemble those of acute retro-caecal appendicitis, acute cholecystitis or acute hæmorrhagic pancreatitis.

Diagnosis. The only sure method of diagnosis is by means of X-rays. As already stated, the clinical picture is atypical. At times pain of a deep boring nature or epigastric discomfort is perhaps a troublesome feature. Tenderness localised to the diverticulum by palpation during fluoroscopy is stated by Case and MacLean to indicate that diverticulitis is present.

Treatment. Diverticula which are found in a routine examination of the gastro-intestinal tract and which do not appear to produce symptoms are best left alone, as the operation for their excision may at times be difficult and not free from danger. Those which are asso-

* MacLean, *Surg., Gynec. & Obst.*, 37:6, 1923.

ciated with vague upper abdominal symptoms demand a thorough investigation to eliminate other causes. If this investigation should prove negative, but symptoms persist, medical measures, as already outlined, should be given a trial and only when these fail should surgery be invoked. In other words, operation is advised when symptoms persist and when complications have arisen.

The operative procedure consists of exploring the abdomen through a right upper paramedian incision and mobilising the duodenum by dividing the peritoneum along its right (lateral) border. The strong fascia propria which is exposed after incising the peritoneum is carefully snipped with scissors, after which the fingers steal under the duodenum and turn it over to the left (medialward) until a small arcade of blood vessels from the pancreaticoduodenal artery can be seen entering the concave inner border of the gut. The frail pouch and the yellow lobulated head of the pancreas now come into view. The diverticulum, which is nearly always situated near the termination of the common bile and pancreatic ducts, will be found to be slightly adherent to the pancreas and should be daintily teased away from the compressed connective tissue strands which surround it, using a small swab held in the jaws of a hæmostat or fine non-toothed dissecting forceps. The fundus, when freed, should be clipped with a hæmostat to steady it and to facilitate the dissection and isolation of the pedicle. A few small blood vessels which will be found supplying the sac should be ligated with fine silk and divided, after which a purse-string suture of fine silk or catgut should be inserted into the duodenal wall so as to encircle the pedicle of the sac, which is then clamped, securely tied in the groove thus produced, and divided. *The diverticulum with its stalk which has been cut almost flush with the duodenum is now removed and may be placed in a small sterile container for bacteriological and microscopical investigation.*

The operation is completed by tying the purse-string suture and by reinforcing the invaginated area with two or three Lembert sutures of silk. Drainage is unnecessary.

In certain cases where the mouth of the diverticulum is wide and capable of admitting, say, two fingers, there may be an extensive gap to be sutured in the duodenal wall after excision of the pouch. In such cases the defect should be repaired at right angles to the long

axis of the bowel so as to avoid subsequent obstruction. Invagination of the sac into the lumen of the duodenum is not advised, since it may lead to obstructive symptoms at a later date.

The treatment of chronic duodenal ulcer associated with marked pouching—false diverticula—calls for no special mention here. I have successfully treated a number of such cases by gastro-duodenal resection.

Operation will be indicated where there is inflammation or gangrene of the sac. In such cases the sac should be excised and the stump inverted into the gut with a circular suture, as in the operation of appendicectomy. Owing to the sodden nature of the duodenum and the friability of the parts, suture may be difficult, and as a precautionary measure both intra- and extra-peritoneal drainage should be provided. Diverticula attached to the third or fourth part of the duodenum may be approached through the posterior peritoneum beneath the mesocolon, and pains should be taken in making this exposure to avoid the vulnerable right colic artery (see fig. 16).

CHAPTER 6

INJURIES OF THE STOMACH AND DUODENUM

The causes of injuries of the stomach and duodenum may be grouped together as follows:

Violence from without: (a) Indirect trauma, such as may be caused by kicks or severe blows in the epigastrium, often with subcutaneous contusions; (b) direct trauma with external wound, *e.g.*, the result of gunshot wounds, stabs, etc.; (c) operative trauma, *i.e.*, injury to the stomach or duodenum during the conduct of an operation.

Violence from within: (a) The passage of instruments, *e.g.*, the gastroscope, into the stomach for the purpose of treatment or enquiry; these may cause injury if not used with due care and precautions; (b) the swallowing of highly corrosive fluids or the ingestion of foreign bodies which produce mechanical injury; (c) over-distension of the stomach with gas or fluids when these are used for diagnostic purposes; (d) spontaneous rupture of the stomach.

RUPTURE

Complete Rupture. (a) Extra-peritoneal; (b) intra-peritoneal; (c) both extra- and intra-peritoneal.

Incomplete Rupture. This involves (a) the serous coat; (b) the mucous membrane; (c) the muscular coat, and (d) a combination of any two of the above.

Rupture of the stomach due to violence from within is very rare nowadays and the subject can be briefly dismissed in a few words. Henning (1937) in his *Text-book of Gastrosocopy* states that the passage of the flexible instrument which has been in common use now since 1932 is attended with as little danger of injury to the stomach or œsophagus as is the passage of a soft stomach tube. Perforation of the gullet just above the cardia or of the walls of the stomach, many cases of which were recorded when the rigid gastroscope was employed, is now an almost unheard of catastrophe and only occurs

when some gross pathological condition has made the œsophagus abnormally thin or friable or when the surgeon is lacking in an ordinary degree of skill. The special construction of the new flexible instrument, such as the Wolf-Schindler, prevents any injury to the œsophagus or to the stomach. Henning had no mishap to report in examining well over 1,400 cases, and similar experiences were recorded by Harold Edwards, Rogers and Herman Taylor.

The swallowing of highly corrosive fluids may literally burn a hole through all the coats of the stomach, but here death rapidly supervenes from shock, suffocation due to œdema of the larynx, a fulminating pneumonia, acute toxæmia, or, if the patient survives for a few days, from an acute spreading peritonitis. This must, however, be an exceedingly rare cause of perforation of the stomach.

Certain sharp foreign bodies may be swallowed, and these may injure or penetrate all the walls of the stomach and duodenum and produce a localised abscess or peritonitis. The investigation and management of such cases are described on page 86.

Rupture of the stomach from over-distension with gas or fluids employed for diagnostic purposes does not occur nowadays, although before the advent of radiological methods of investigation some fatalities were reported as the result of employing these means. Spontaneous rupture of an apparently healthy stomach is an exceedingly rare and interesting condition, and all recorded cases have proved fatal. Glassman (*Ann. Surg.*, 89:247, 1929) gave an account of 14 cases which he was able to collect from the literature. Rupture most frequently occurs in the region of the lesser curvature, as here the gastric wall is at its thinnest, the mishap being attributable to a spontaneous over-distension which may be occasioned by some severe muscular effort such as lifting a very heavy weight or by a fierce attack of vomiting. As soon as the rupture takes place the patient is overwhelmed by violent abdominal pain, and all the clinical phenomena are indistinguishable from those of an acute perforated peptic ulcer involving profound shock demanding immediate exploratory operation.

The stomach or duodenum may be injured during the course of an operation, and such an accident is especially prone to occur during splenectomy, during secondary operations upon the biliary passages, and in dealing with the right renal pedicle in a difficult nephrectomy.

A portion of the greater curvature may be crushed by a hæmostat when ligating the upper quarter of a shortened and tendinous gastro-splenic omentum, while the sharp-toothed points of a strong, long, curved pedicle clamp may inadvertently bite into the posterior wall of the second part of the duodenum with disastrous effects when it is engaging a stout, short, thickened, oedematous renal pedicle. Again, if the renal artery and vein are not properly cleared in a rushed right-sided nephrectomy, it is possible to drag a small section of the thin retroperitoneal portion of the duodenum into the embrace of the encircling pedicle ligature. This accident is not usually recognised at the time of the operation, and for a few days the patient may appear to be making quite a good recovery. The ligature, however, slowly strangles or ulcerates through the gut wall, and the digestive juices pour through the rent into the empty renal fossa, where a boggy, tender, fluctuating tumour rapidly forms. The wound becomes ominously infected, the edges gape, and tell-tale bile-stained fluid soon appears on the surface to sear the skin and to play havoc with the wound.

One of the chief difficulties encountered in performing secondary operations upon the biliary passages is the freeing of the omentum, colon, stomach and duodenum from the under-surface of the anterior abdominal wall (especially in the region of the previous incision) and from the gall-bladder fossa. It is often a perilous and time-consuming dissection, calling for the greatest care, patience and experience. The parts involved in the adhesions must be restored to their normal anatomical positions before the surgeon proceeds to define the bile ducts and perform the necessary operation upon them. The greatest anxiety is encountered in those cases in which, following cholecystectomy, the duodenum and the pyloric end of the stomach become fused to the portal fissure and to the important structures which lie in the right free border of the gastrohepatic omentum, a state of affairs which is frequently seen in secondary operations upon the bile ducts.

In order to obtain a satisfactory exposure it is imperative that the stomach and duodenum should be dissected away from the liver by cautiously snipping the widespread adhesions and by drawing them downward with Deaver retractors. The exposure afforded is at best poor and limited, the cavity is deep, oozing free, troublesome and

difficult to control, the liver soft and friable, and the duodenum distorted and easily bruised, cut into or torn. A traction diverticulum of the duodenum may have formed by adhesions dragging a portion of the gut and fixing it to the raw area of the gall-bladder bed, and this, lying in a cuff of fibrous tissue, may be inadvertently severed. If such an accident is recognised at the time it can be satisfactorily rectified by closing the small perforation with a purse-string suture; but if it passes undetected general peritonitis or an external fistula will develop. Sloughing of a portion of the duodenal wall, too, may be caused by rough handling, by bruising, or by pressure of a hard rubber tube which has been inserted for drainage purposes.

GASTRIC WOUNDS

In cases of severe injuries to the epigastrium by blunt trauma (in which the abdominal wall is not perforated) the empty stomach is less likely to be injured than the liver, the spleen or the fixed portions of the duodenum, since it is of a tougher consistency and is protected by the ribs. When, however, it is distended with gas or fluids it is more vulnerable, as a large area of its anterior surface and of the greater curvature comes to lie directly against the abdominal wall, and the viscus becomes tightly fixed in its bed between unyielding structures such as the spine behind and the diaphragm and the liver above.

Wounds of the stomach, when caused by injuries from without, are best described as *penetrating* or *subcutaneous*. In the former, the abdominal wall is penetrated or completely torn through at one point, and the stomach itself is injured. Such wounds may be caused by bullets, stabs and perforations from knives or other sharp instruments, machinery, falls upon sharp objects, and the like. Subcutaneous wounds are caused by sudden violence such as kicks, blows, falls, buffer or run-over accidents, motor-car or aeroplane crashes, and so forth, and are due to the stomach being crushed against the projecting spinal column. In these cases, although the abdominal wall may be contused, there is no gross breach in its continuity. The nature and the extent of the damage done to the wall of the stomach show wide variations in individual cases. In some, only one coat, or possibly two, may be torn, and the injury may pass undetected. In

bursting lesions, due to compression for instance, deep longitudinal fissure involving the seromuscular coats may be produced, and these usually lie parallel to the greater, or more frequently the lesser, curvature of the stomach. In other cases, the stomach wall may be extensively bruised or be the site of a tense localised hæmatoma. The danger of these mural hæmatomata is that they may become infected and the abscess which results may cause a circumscribed patch of necrosis which, on separating, will leave a gaping hole through which the gastric contents are free to pour into the abdominal cavity. In severe cases the tear which involves all the coats of the stomach is often extensive and jagged, and the liver, spleen, ribs, etc., rarely escape injury.

In penetrating wounds, concomitant trauma to neighbouring viscera is a common occurrence, and the stomach itself may be perforated in more than one place.

Signs and Symptoms. The signs and symptoms cannot be separated from those of abdominal wounds in general. The first symptoms are those of shock or hæmorrhage; the first signs are those of peritoneal irritation. In most instances it is impossible to distinguish between shock and hæmorrhage; but collapse is always marked when a large amount of blood is lost.

In subcutaneous injuries the fixation of the muscles and the pain elicited on palpation may be due to contusions of the abdominal wall, although on the other hand it may be caused by flooding of the peritoneal cavity with blood or gastro-intestinal contents. In cases of doubt therefore it is wiser to "look and see."

Immediately after the injury the pulse is feeble and thready. After a time, on recovering from the shock, the pulse steadies. If, following this improvement, the pulse-rate continues to mount in spite of supportive measures, operation should be advised.

Diagnosis. The diagnosis is made on the following:

1. The history of the accident as recorded by the patient or by eye witnesses.

2. Examination of the patient. This includes: (a) general examination to exclude other injuries, *e.g.*, fracture; (b) abdominal examination; (c) fluoroscopic examination; and (d) the passage of a stomach tube and the examination of the withdrawn gastric contents for blood.

In cases of blunt violence sufficient to rupture the stomach, the liver, spleen and other abdominal viscera are, as already stated, almost invariably injured at the same time. The initial clinical picture is therefore one of severe intraperitoneal hæmorrhage, and if the patient survives for twelve to twenty-four hours this is transformed into an acute spreading peritonitis. The patient when first seen will be blanched, collapsed and struggling for air, while later on the tender, board-like "silent" belly will proclaim the true state of affairs. If the injury is due to a bullet, inspection of the parietal wound will give a rough idea as to what viscera are implicated. If no wound of exit is found, the bullet should be sought for with the flat of the hand. It may be felt under the skin, or at least its presence may be suspected if an exquisitely sensitive spot is found. A fluoroscopic examination is the next procedure, carried out to determine:

The position of the bullet; the amount of air or fluid in the stomach; whether air has escaped from the stomach into the peritoneal cavity—pneumo-peritoneum. Pneumo-peritoneum indicates that a hollow, gas-containing viscus like the stomach or colon has been perforated, and this in itself is an urgent plea for expeditious surgical enquiry.

Perforations of the small intestine do not produce an immediate pneumo-peritoneum, but with the onset of peritonitis and distension, leakage of gas occurs. In most cases of suspected injury to the stomach it is a wise measure to pass a stomach tube and aspirate the gastric contents. The presence of blood in the juices withdrawn would favour a diagnosis of injury to the stomach.

Complications. The complications are those of injuries to the upper abdomen which implicate the liver, gall-bladder, spleen, pancreas and intestine. In penetrating wounds and severe crushing accidents the thoracic organs and bony skeleton are also frequently involved.

Prognosis. The prognosis depends upon: (1) The patient's condition on admission; (2) the nature of the complications; (3) the amount of shock, hæmorrhage or infection; (4) the number of wounds; (5) the character of the injury to the stomach and other viscera; (6) the judgment and technical skill of the surgeon; (7) the care with which the pre-operative and post-operative treatment are

conducted, in addition to the skill exercised in the treatment of complications, *e.g.*, fractures.

In many cases of severe crash, run-over accidents, and the like, the patient's condition is hopeless from the start owing to the seriousness and multiplicity of his injuries. For instance, in addition to rupture of the stomach he may be suffering from lacerations of other abdominal viscera, compound fractures, concussion, etc. In cases of rupture of the stomach due to indirect violence, in which perhaps only the liver or spleen is simultaneously involved, if laparotomy is performed within six hours of the infliction of the injury, the prognosis is tolerably good. With gunshot wounds the prognosis is grave, the mortality being about 50 per cent. This high mortality will be reduced when it is universally recognised that all cases with penetrating wounds of the abdominal wall have also in all probability penetrating wounds of the viscera, and that the patient's best chance of recovery lies in immediate operation.

While the patient is awaiting operation, anti-shock remedies should be assiduously applied until the blood pressure commences to rise and there is an all-round general improvement. If the blood pressure does not rise, or if it falls, the outlook is well nigh hopeless, calling for the desperate risks associated with a rushed laparotomy.

TREATMENT OF GASTRIC INJURIES

The pre- and post-operative care and the indications for operative interference in cases of gastric injuries cannot be dissociated from those cases which have sustained injuries of other abdominal viscera. Pre-operative treatment will comprise the following:

1. Cleansing the abdominal wound (if any), painting the abdominal wound with antiseptic solution, and applying a dressing and firm abdominal binder.

2. The injection of omnopon, gr. $1/3$, and scopolamine, gr. $1/150$, as soon as the patient is admitted to hospital.

3. The passage of a stomach tube and the aspiration of the gastric contents. The fluid removed is examined for blood. Irrigation of the stomach and the introduction of fluids by mouth are not permitted in any case.

4. The application of heat to the abdomen and extremities.

5. Making a 10-minute record of the pulse-rate on a special pulse chart. A rapidly mounting pulse-rate denotes hæmorrhage or peritonitis.

6. The intravenous administration of blood by the slow-drip method, as elaborated by Marriott and Kekwick. Before operation the drip is controlled to 5 drops per minute, during operation to 15 drops per minute, while after operation it is increased to 30 drops per minute. Intravenous saline solutions are not given, although there can be no objection to the exhibition of fluids by hypodermoclysis.

7. Cardiac stimulants (which should be given sparingly).

8. The recording of the systolic blood pressure at frequent intervals. If on admission the systolic blood pressure is low, say, 80, indicating a severe degree of shock, it may be wise to postpone operation for a short time, during which anti-shock remedies are inaugurated. A rising blood pressure is a good omen.

Operative Procedure. If the blood pressure is normal, a spinal anæsthetic is given, this being preferable to a general anæsthetic on account of the perfect relaxation thereby afforded. If the blood pressure is low and the patient's condition is desperate, a regional anæsthetic is to be preferred.

The abdomen is explored through a midline or a paramedian incision which must be of ample proportions since most of the viscera will have to be examined by sight. In this type of case I find Devine's self-retaining abdominal retractor with artificial "hands" most useful. After protecting the wound edges with Lahey's cellophane squares, the retractor is placed in position and all blood, fluid, and possibly food particles are withdrawn from the peritoneal cavity by means of a wide-bore suction tube. After packing off the intestines, the "hands" are arranged so as to afford maximum exposure of the stomach, duodenum, liver, spleen and pancreas. Exposure must be good and each organ must be examined methodically, as the stomach may be perforated in more than one place and continuous viscera may be pierced. If a wound is found on the anterior wall of the stomach, after it has been closed the posterior surface should be examined by opening the gastro-colic omentum. Small perforations should be closed by means of purse-string sutures, while linear tears should be stitched with three rows of sutures, the first row uniting the edges of the mucosa, the second the seromuscular coats, the third being intro-

duced as interrupted Lembert sutures of fine silk which wholly invaginate the suture line.

Following suture of the stomach, colon or intestine in cases of injury, drainage of the injured area or of the peritoneal cavity is not as a rule instituted, as this favours fistula formation and adhesions. Where, however, general peritonitis is present, it is the custom of most surgeons to use drainage tubes for twelve to twenty-four hours, although this is, in my opinion, of questionable benefit.

The treatment of thoraco-abdominal wounds is one of the most difficult in so-called traumatic surgery. In most instances it is best to explore the abdomen first, to deal with wounds of the diaphragm from below, to reduce portions of the stomach or intestines which have herniated into the pleural cavity, and to repair such lacerations as may be found in the abdominal viscera before attending to the injuries in the thoracic organs.

Post-Operative Treatment. This is the same as for abdominal wounds in general and may be epitomised as follows:

1. No fluids are permitted by mouth for two to three days.
2. The continuous use of a Levine or Ryle stomach tube is advised.
3. Fluids are administered by intravenous continuous blood drip transfusion, by intravenous salines with glucose, or by hypodermoclysis.
4. Complications are treated as they arise, the commonest being broncho-pneumonia, diffuse peritonitis, and subphrenic abscess.

DUODENAL INJURIES

The duodenum is afforded relative protection against injury in all portions except where it crosses the spine. According to Kellogg, rupture of the intestine involves the duodenum in about 16 per cent of cases, and less than 200 cases have been recorded in the literature to date. Liebowicz (*Zentralbl. f. Chir.*, 57:1278, 1930) collected reports of 176 cases, while Kellogg (*The Duodenum*, 252, 1933) carefully analysed 169 cases. One of the most interesting and comprehensive studies of the subject was published by Berry and Giuseppi (*Proc. Roy. Soc. Med.* 2:41, 1908), who recorded the details of 23 cases encountered in ten London hospitals between 1893 and 1907. Rowlands (*Brit. M. J.*, 1:716, 1923) described 23 cases of ruptured

duodenum out of 381 cases of ruptured intestine. This type of injury predominates in males in a ratio of about 8:1, and occurs most frequently in patients between the ages of 10 and 35 years. Laceration or rupture of the duodenum usually results from blunt trauma, such as the kick of a horse, applied to the right upper quadrant of the abdomen, the duodenum being forcibly compressed against the spine or violently dragged upon at its fixed points. The factors concerned in the production of this injury therefore closely resemble those which cause intestinal rupture elsewhere.

Varying degrees of rupture may occur, involving the anterior or posterior wall, or both, or there may be a complete division of the bowel. In rare instances the duodenum may be avulsed at both its fixed points. Associated lesions most frequently implicate the stomach, liver, spleen, pancreas, small intestine or right kidney.

Signs and Symptoms. The signs and symptoms will vary considerably in individual cases, and will, of course, depend upon the position and nature of the injury to the duodenum as well as to coincidental lesions to other viscera. Where, however, a portion of the anterior wall of the duodenum has been torn or the duodenum has been completely ruptured—intraperitoneal rupture—the clinical picture is identical with that of rupture of a hollow viscus, *i.e.*, rupture of the stomach, there being severe pain, chiefly localised to the right side, shock, vomiting (50 per cent of all cases), tenderness, and increasing rigidity of the abdominal wall.

In cases of rupture of the *retroperitoneal portion* of the duodenum—and this part of the bowel is involved in 30 per cent of cases—the signs and symptoms are, for the first few days following the injury, vague and misleading, and the condition may remain undiagnosed even after the abdomen has been opened. As soon as the shock due to the accident has passed off, the patient may express himself as feeling better, the temperature and pulse-rate may be normal or only slightly raised, and the appetite may return. On examination, however, some rigidity and tenderness will be made out below the right costal margin, extending to the renal area behind. Later, the abdominal rigidity increases, the pulse becomes more rapid, vomiting is a troublesome feature, toxæmia is marked, and a gradually increasing, right-sided dullness, continuous with that of the liver, may be made out, the post-renal angle becoming tender, boggy, red and

swollen from the extravasation of duodenal juices, often leading to a mistaken diagnosis of perinephric abscess.

Prognosis. The prognosis is very grave. In Kellogg's series of 169 cases there were but 14 recoveries, a mortality of about 92 per cent. Of these cases 93 per cent were operated upon, with an operative mortality of nearly 85 per cent. Of 60 of these patients who were operated on, only 7 recovered.

Treatment. The pre-operative treatment of duodenal injuries is the same as that for rupture of the stomach, an important feature being the introduction of a Levine or Ryle tube into the stomach, preferably through the nostril, whereby continuous suction may be applied both before and after operation.

The abdomen is explored through a right paramedian incision, and if an anterior rupture of the duodenum is discovered it is closed with a purse-string suture or with a series of interrupted Lembert sutures, the suture line being reinforced with a portion of adjacent omentum. Drainage is not necessary. If the duodenum is found to be completely divided, both ends of the bowel should be closed and a gastro-jejunostomy performed as speedily as possible. This, however, is such a lethal injury that a fatal outcome is almost inevitable. In cases of rupture of the retroperitoneal portion of the duodenum, the rent in the bowel should be displayed by incising the peritoneum on the other side of the duodenum and by drawing the gut medialward. The extravasated duodenal fluid should be aspirated or mopped up, and the tear should then be carefully sutured with interrupted silk sutures. Extra-peritoneal drainage is provided by a soft, wide-bore rubber tube which emerges through a stab wound in the right flank. Its inner end should not abut against the injured intestine, as this would favour the formation of an external duodenal fistula. A Witzel's jejunostomy completes the operation.

No fluid nourishment is administered by mouth until it is certain that the sutured area has healed satisfactorily. Meanwhile the stomach tube remains in situ and continuous suction is maintained, the aspirated juices being returned to the intestine via the jejunostomy tube. If the patient survives the operation and an external duodenal fistula does develop, continuous suction is applied to the tube in the flank and the fluids obtained are reintroduced through the jejunostomy, as originally suggested by Cameron.

CHAPTER 7

GASTRIC AND DUODENAL FISTULÆ

GASTRIC FISTULÆ

There are two varieties of gastric fistulæ; namely, external or cutaneous and internal.

An *external fistula* may occur after imperfect closure of a perforated gastric ulcer, after wide gastric resections, shortly after a penetrating wound of the epigastrium, and following drainage of a perigastric (subphrenic) abscess caused by slow leakage from a chronic ulcer of the stomach. A simple ulcer or a malignant growth of the stomach may conceivably become attached to the abdominal wall and perforate it, thus forming a cutaneous fistulæ; but such lesions of the stomach are more prone to give rise to the internal variety, of which gastro-colic fistula is a good example.

External gastric fistulæ may be divided into two main groups: In the *first* group the clinical picture is that of a slow leak from a small perforation of the stomach causing little damage to the abdominal wall or surrounding skin, the patient being in good condition. Such a fistula produces a minimum amount of disturbance and often heals spontaneously. In the *second* group the aperture in the stomach is rapidly enlarging. The abdominal incision breaks down and sloughs, and there is an uncontrollable, profuse outpouring of corroding digestive juices which inflame and ulcerate the skin. Furthermore, there is a considerable loss of fluids, chlorides and nourishment, with consequent dehydration, toxæmia and inanition. In a very short while the patient is beyond the reach of any surgical help and he becomes haggard, drowsy and alarmingly emaciated. It is not surprising, therefore, that the mortality in this group is very high—over 50 per cent.

Palliative Treatment. Conservative or expectant measures are advised:

1. *After gastrostomy for a perforated gastric ulcer.* When the per-

foration has resulted in a hole of more than 1 cm. wide and the surrounding stomach wall is cheesy with inflammation, Keynes considers that it is a waste of time to attempt closure by means of interrupted sutures. A rubber catheter passed through the hole and led downward into the duodenum will serve both as a stopper and also as a means of administering fluid nourishment. When the gastrostomy tube works loose and has to be withdrawn, a gastric fistula results; but if the abdominal wound is protected with alkaline dressings and if the medical treatment instituted for the cure of the ulcer has been efficient, the fistulous tract will slowly but surely close. At a later date when the patient's general condition is satisfactory, the stomach should be examined by means of gastroscopy and fluoroscopy to ascertain whether the ulcer crater has healed, is healing or is still active. If medical measures prove ineffectual, partial gastrectomy must be advised.

2. *When a cutaneous fistula develops after suture of a perforated gastric ulcer.* This is a serious and often fatal complication and is due either to faulty closure of the hole in the stomach or to inadequate plugging of the perforation with an omental pad. If in attempting closure of the perforation the surgeon finds that the sutures persistently tear out and produce a large aperture in the stomach wall, the omentum should be gathered together and sutured over the opening.

Following this operation the stomach should be kept empty by means of continuous suction for at least three days, and fluids and sugar should be introduced into the circulation by venoclysis in order to maintain the patient's strength. If in spite of this there is an ominous discharge of gastric juice through the incision in the abdominal wall, prompt measures, as detailed below, should be instituted without further delay.

3. *Following the drainage of a subphrenic abscess due to a leaking gastric ulcer.* In such cases the wound and the surrounding skin for a wide area should be thickly smeared with ballerina paste (fire-hardened aluminium metal made into a stiff paste with paraffin, one part, to zinc oxide ointment, two parts) and then covered with gauze soaked in a strong solution of sodium bicarbonate. Cunningham (*J. Am. M. Ass.*, 98:1643, 1932) considers that the best single application is pure copper bronzing powder, 180 to 200 mesh, dusted

over the moistened skin; slight rubbing fills the interstices of the broken and inflamed skin and gives a burnished metallic finish which is impervious to moisture. If the discharge through the tube calls for frequent change of dressings, continuous suction should be applied and the withdrawn gastric juice should, after being diluted, be run into the rectum by Murphy's method. It is important to combat dehydration, toxæmia and alkalosis, and for this purpose the injection of large quantities of saline or McVicar's solution, consisting of 100 grammes of glucose to 1 litre of water, is prescribed. As much as 6 litres may be administered in twenty-four hours. If, in spite of supportive measures, the patient appears to be losing ground, a jejunostomy should be performed under local anæsthesia and the aspirated gastric juice and fluid nourishment be introduced into the small intestine through the catheter.

4. *When a gastric fistula occurs after partial gastrectomy.* To reopen the abdomen and to attempt repair of the gaping hole at the anastomotic junction is to court disaster, as the tissues involved are buttery and necrotic and will not hold any sutures, however carefully or skilfully they may be introduced. The opening is most frequently found at or about the lesser curvature, as this is the weakest and the thinnest area of the stomach wall, and is in addition the most perilous point of any end-to-side gastro-jejunal anastomosis.

As soon as the catastrophe occurs, the wound and the skin around should be protected with copper bronzing powder or ballerina paste, all nourishment by mouth should be stopped, a solution of glucose and saline should be given intravenously, a drainage tube should be introduced into the fistulous tract and suction instituted, and a Levine tube should be passed into the stomach and an attempt made to lead it—with the aid of X-rays—into the distal jejunal loop just beyond the ill-fated anastomosis. If this succeeds, a jejunostomy will not be required, as feeding may be carried out by means of the Levine tube.

Operative Treatment. Extensive surgical procedures are contra-indicated for the treatment of gastric fistula, owing to the high death-rate which results. Jejunostomy, however, can be performed with the minimum degree of risk and can be used immediately for the introduction of food, chemicals, vitamins and diluted gastric secretions. Witzel's valve-like method (see page 496) is the best, as

leakage into the peritoneal cavity does not occur and when the catheter is withdrawn the sinus soon closes. Potter (*J. Am. M. Ass.*, 92:359, 1929) has drawn attention to the fact that the simple jejunostomy made with purse-string sutures has in itself created most irritating and stubborn intestinal fistulæ.

DUODENAL FISTULA

Duodenal fistula may be internal or external.

Internal Duodenal Fistula. This is comparatively rare and is of little surgical importance. The fistulous communication may occur as the result of trauma, an operation, or disease between the duodenum on the one hand, and the stomach, colon, gall-bladder, bile ducts, etc., on the other hand. The communicating channel is said to be *direct* when the opening is large, and *indirect* when the tract between the two viscera is narrow and precarious. By far the commonest type of internal duodenal fistula seen is that which occurs between the duodenum and gall-bladder or between the gall-bladder and the common bile duct as the result of gall-stones. An adherent gall-bladder favours the pressure of calculi against the duodenum, leading to slow necrosis and eventually to the discharge of the stones into the bowel. When a large gall-stone is passed per rectum it is justifiable to assume that a cholecysto-duodenal fistula exists. The diagnosis can be confirmed by means of radiography after the administration of an opaque meal. The barium will be seen passing through the superior aspect of the duodenal cap into the gall-bladder or bile ducts which will be clearly outlined. Kellogg and Kellogg (*Am. J. Surg.*, 24:85, 1934) point out that the formation of a fistula may either relieve symptoms or else cause peritonitis, infection of the bile tract, localised abscess, obstructive adhesions, or the formation of a mass which simulates malignant disease.

Treatment of Internal Duodenal Fistula. An internal duodenal fistula which causes no symptoms should not on any account be disturbed. If treatment is indicated, operative interference will be required, but this will vary according to the mechanics of the problem. When, for example, the fistula is due to gall-stones, the two viscera should be carefully separated and the aperture in the duodenum closed in such a way that narrowing of the gut does not result. After

excising the common ducts and probing them to make sure that they are patent, the gall-bladder is removed and the common duct is drained by means of a T-tube.

External Duodenal Fistula. Nearly all cases that are seen occur after operations upon the stomach and duodenum, the gall-bladder and bile passages, and the right kidney (nephrectomy), while only a few are due to rupture of the duodenum. This fact is brought out by Kittleson (*Surg., Gynec. & Obst.*, 56:1056, 1933) who, in analysing 88 cases of external duodenal fistula, showed that in 30 cases the fistula followed operations upon the gall-bladder and bile ducts, in 22 cases operations for perforated duodenal ulcer, in 8 cases after nephrectomy, in 8 cases after resections of the stomach and the first portion of the duodenum for cancer, in 7 cases after operations for acute retrocaecal appendicitis with obstruction, in 6 cases after rupture of the duodenum, and in 7 cases from other causes.

I have already attempted to show how in performing secondary operations upon the gall-bladder and bile passages the duodenum may be injured, and what precautions should be taken to prevent such a mishap and how during a difficult nephrectomy a small portion of the duodenal wall may be picked up in the clamp and become crushed or else be ligatured to the vascular pedicle (see page 133). It now remains to consider how this complication following operations upon the stomach and duodenum accounts for over 80 per cent of the cases. The majority of this group are due to inept methods of closing a perforated duodenal ulcer, especially when the hole is very large and the walls of the gut are unduly sodden with inflammatory products. In the very rare cases which are occasionally observed in which suturing proves impracticable, the opening should be securely covered with omentum, the pylorus occluded, and a gastro-jejunostomy performed.

External duodenal fistula has been known to arise after the operation of transduodenal choledochostomy for stone impacted in the ampulla of Vater and after pyloroplasty for duodenal ulcer (a comparatively rare operation nowadays), particularly where there has been considerable tension on the suture line. Rupture of the duodenum due to external violence, *e.g.*, penetrating wounds, accounts for a few cases, as does also the operation of excision of a retroperitoneal diverticulum. The most tragic cases of all are those which are seen

after the Polya type of partial gastroduodenal resection for peptic ulcer or gastric cancer. Here, owing to imperfect invagination of the duodenal stump, to the use of unsuitable suture material, to omitting to insert additional sutures of silk after the inversion of the duodenal stump is complete, or to neglecting to protect the finished suture line in the duodenum with adjacent omentum, a portion or the whole of the duodenal cul de sac blows out, with the result that one of three conditions ensues: a subphrenic abscess, general peritonitis, or a small external duodenal fistula with a slow leak or a large duodenal fistula with a profuse leak.

It is perhaps surprising to find in the literature several references to this complication following appendectomy for acute retrocaecal appendicitis, but the position of the appendix (high up, retrocaecal and overriding the duodenum), the condition of affairs displayed at operation (the appendix large, œdematous, soft with gangrene, and embedded in a mass of adhesions), the technical difficulties associated with its excision and the necessity for inserting a rubber drainage tube down to the septic oozing area which may, if left in situ too long, cause pressure necrosis of the duodenal wall, would all at times predispose to fistula formation. Kittleson reported seven such cases, and I have had one in my own practice.

Symptoms. The symptoms are dependent upon the character and quantity of the discharge and the size of the fistula itself. When the opening is small and is discharging a little mucus with perhaps only a slight trace of duodenal juice without causing any irritation of the skin, healing is rapid. When, however, the fistula is large and great quantities of viscid bile-stained alkaline fluid constantly gush through the semi-digested wound, the patient rapidly becomes emaciated, toxæmic, profoundly prostrated and dehydrated, and the position is grave, calling for energetic and immediate treatment to prevent a fatal issue.

Walters and Bollman (*J. Am. M. Ass.*, 89:1847, 1927) called attention to the changes in the blood resulting from duodenal fistula and to the resulting toxæmia. The blood changes consist of a diminution in plasma chlorides and an increase in urea and in the carbon dioxide combining power of the blood. Fatal results are due to alkalosis, dehydration, exhaustion, infection and toxic nephritis.

Prognosis. Colp in analysing 61 cases in 1923 stated that

the prognosis is always grave, except in those which follow gall-bladder operations, in which the opening is invariably small. These cases, as a rule, do well with conservative treatment. As far as the other cases are concerned, the general mortality is about 50%, both after conservative and operative measures. The figures based upon conservative treatment can probably not be improved, but there is no doubt that the operative mortality can be definitely lowered. To accomplish this, surgical measures must be employed as soon as the fistula has formed and the proper operation must be employed. Simple suture, except for retro-peritoneal fistula, must absolutely be abandoned. Gastro-enterostomy with pyloric occlusion with a general mortality of 85% offers very little help. A jejunostomy at present has a general mortality of 45%, and from all angles it certainly appears to be the operation of choice especially if it is combined with the aspiration of the contents of the fistula.¹

In Kittleson's series (1933) 65 of 94 cases were treated conservatively with a mortality of 27.7 per cent; 30 cases were treated surgically with a mortality of 50 per cent. The mortality of all groups including all types of treatment was 35.8 per cent.

Treatment. Operative measures include:

1. Suture alone.
2. Suture plus gastro-jejunostomy.
3. Suture with pyloric exclusion plus gastro-jejunostomy, and
4. Jejunostomy alone.

In slight cases, for example, with a small chronic mucous fistula which will not heal with conservative treatment, re-opening of the abdomen and suture of the perforation in the duodenum will be successful. In the more severe cases it is doomed to failure owing to the friable condition of the bowel wall and to the great pressure within the duodenum during digestive activity. Suture with gastro-jejunostomy is inadequate; when supplemented with pyloric occlusion it meets the requirements but is a hazardous undertaking owing to the patient's general condition. It has, according to Colp, a mortality of 85 per cent.

Jejunostomy is the operation of choice when it is imperative to operate when a patient has symptoms of inanition, toxæmia and prostration, as it is a simple and easy procedure, and can be carried out under local anaesthesia with comparatively little disturbance. McGuire (*Surg. Gynec. & Obst.*, 30:460, 1920) and Erdmann (*Ann. Surg.*, 73:793, 1921) appear to be the first surgeons to advocate jeju-

¹ Colp, *Ann. Surg.* 78 725, 1923. Courtesy of J. B. Lippincott Co.

nostomy, jejunostomy feeding and suction for cases of duodenal fistula. Jejunostomy by Witzel's method is the most logical measure as it permits ingestion of fluids and foods by the intestine below the fistula and of the introduction of the aspirated duodenal juices into a portion of the gut where it is especially needed for digestive purposes.

Of all non-operative measures that of Potter (*J. Am. M. Ass.*, 88:899, 1927) which was later slightly modified by Warshaw is the best. Briefly, the method consists of destroying the potency of the duodenal juice by neutralising its alkalinity with tenth normal hydrochloric acid and by completing the inactivation of the excess by adding beef juice and olive oil in sufficient amounts to use up the juice before it can attack the tissues of the abdominal wound. The details of this treatment are best described in Warshaw's own words:

A plan of treatment based on the Carrel-Dakin continuous irrigation method was devised to eliminate the frequent wet dressings. This was done as follows: a 6-inch square of gauze containing about eight thicknesses was prepared with a hole cut in its center the same size as the crater in the abdominal wall. Around the border of this hole was sewed a skirt of gauze about 2 inches wide so that, when it was spread out flat over the wound, the skin for a radius of from 2 to 3 inches from the margin was completely covered and the central skirt lined the walls of the crater. Down through the central opening ran a number 18 French catheter, its lower end entering the fistulous opening in the jejunum for about 2 cm. This catheter conveyed the tenth-normal hydrochloric acid. The circumference of the central opening, where the gauze skirt was sewed to the flat gauze, was encircled by a number 14 French catheter whose sides had been perforated with fine holes 1 cm. apart for a distance of 12 cm. (An ordinary perforated blind-end Dakin tube may be used.) This catheter conveyed the 10% Witte's peptone solution which saturated the gauze and kept the skin, skin edges, and sides of the crater bathed in the fluid. Gauze soaked in tenth-normal hydrochloric acid was packed around the central catheter leading into the fistula so that food could not escape through the fistula. The respective catheters were connected to a source of supply so that a constant drip of the protective solutions at the rate of 10 cc a half hour was directed to the proper point. These solutions consisted of peptone solution to cover the skin and crater wall and supply a protein to be digested by any unneutralized trypsin, and the tenth-normal hydrochloric acid to enter the jejunum and inactivate the digestive ferments before they emerged from the fistula.... Finally, it may be stated that this form of treatment is effective not only in duodenal and pancreatic fistula but also in those anywhere along the small or large intestine. The further away from the duodenum, the less

there is of pancreatic juice with consequent tissue digestion. Skin irritation is the signal for its immediate employment. Cure is to be expected.²

SUMMARY OF MANAGEMENT

1. Replace by intravenous salines the fluid and also the sodium and chlorine ions lost.

2. Maintain nutrition by: (a) intravenous glucose 5 per cent solution; (b) oral feeding. McEvers (*Surg. Gynec. & Obst.*, 58:786, 1934) suggests that reliquified recolac, boiled milk, acidophilus milk or any reliquified milk concentrate should be used to buffer the tryptic action of the secretion before its exit from the duodenum. Six ounces of any of the above preparations should be given by mouth every two hours; (c) jejunostomy feeding.

3. Institute Warsaw's modification of Potter's method of treatment, and if this fails

4. Protect the skin with copper bronzing powder, insert a catheter into the fistula and apply continuous suction and perform jejunostomy.

McEvers recommends that 8 oz. of reliquified milk powder should be injected into the jejunostomy tube every two hours for eight doses. Concentrated glucose solution, rich in vitamins, can be added if additional nourishment is needed; also concentrated saline solutions to aid in chlorine replacement, and lubricants to aid elimination through the lower bowel. In addition to this, the aspirated duodenal fluid is diluted in saline and returned to the small intestine by injecting it through the jejunostomy catheter.

² Warsaw, *Am. J. Surg.*, 27:139, 1935.

CHAPTER 8

GENERAL CONSIDERATIONS OF GASTRIC OPERATIONS

In this chapter I propose to discuss certain general considerations of gastric operations, together with details of pre- and post-operative management.

INCISION

The various factors relating to the choice of incision for operations upon the stomach and duodenum, the making and closing of the incision, and the management of such wounds and of the complications which may arise are discussed in Part I.

ANÆSTHESIA

The ideal anæsthetic for gastric operations should satisfy the following requirements: (1) It should afford adequate muscular relaxation; (2) it should reduce respiratory excursions to a minimum; (3) it should protect the patient from shock and pulmonary complications, and (4) it should have the least possible toxic effect upon the organism as a whole.

The methods which, in my opinion, best fulfil all these conditions are: (a) Endotracheal nitrous oxide-oxygen-ether combination; (b) high spinal block with percaine solution; (c) field block of the abdominal wall combined with Braun's anterior splanchnic block.

The choice of anæsthetic for major gastric operations is often a difficult problem and must of necessity depend upon the physical state of the patient, the skill of the anæsthetist, and the technical difficulties envisaged or actually encountered at operation. Surgeons and anæsthetists are occasionally at variance as to the best type of anæsthesia for individual cases, rendering it advisable at times to hold a joint consultation shortly before operation to decide upon the safest method. I have been so well served with anæsthetists who have specialised in the endotracheal and the spinal block techniques

that it is difficult for me to find fault with either method, particularly when undertaken with discrimination and with the skill which accompanies experience.

In most cases more than one anæsthetic agent is used; for instance, some of the best results are obtained by employing an inhalation anæsthesia such as nitrous oxide or cyclopropane in combination with an abdominal field block plus a splanchnic block. In this country the favourite spinal anæsthetic agent is percaine, although I am fully aware that in other countries, and in America especially, procaine, metycaine, etc., are used extensively with uniformly good results. But while this may be so, it must be admitted that, in spite of numerous statements made to the contrary, the immediate mortality following the use of spinal anæsthesia is higher than when the inhalation technique alone is employed.

It is generally agreed that spinal anæsthesia is contra-indicated for patients who are cachectic, debilitated, aged, anæmic, or suffering from low blood pressure, and should be reserved rather for those who are robust and in a good state of nutrition. For routine work the nitrous oxide-oxygen-ether combination is used very extensively in Great Britain, often being supplemented by a splanchnic block or by infiltration of the omenta to eliminate visceral shock when technical difficulties are encountered during operation.

Local anæsthesia may be advised: (a) for minor operations, *e.g.*, gastrostomy; (b) for major gastric operations in certain cases; (c) for patients with low systolic blood pressure; (d) for those who are suffering from cardiac or respiratory affections, however trivial in nature; (e) for the feeble and aged; (f) for those who are gravely anæmic or exsanguinated following severe hæmatemesis or melæna due to peptic ulceration or to gastric cancer; (g) for those who show a marked degree of metabolic disturbance in spite of a course of pre-operative medication; (h) for phlegmatic patients and also for the occasional individual who objects to an inhalation anæsthetic or a spinal block.

There are, in fact, but few contra-indications to the use of this method, especially when premedication with omnopon and scopolamine is routinely carried out, nembutal, evipan and avertin being reserved for those cases in which a further fall in blood pressure is not of serious consequence. If it is thought desirable to keep the

patient only lightly unconscious, inhalation of nitrous oxide and oxygen may be employed.

The *technique of local anaesthesia* is simple but somewhat time-consuming. It imposes upon the surgeon the need for patience, precision, gentleness, and a fastidiousness which is well rewarded since shock is considerably diminished, pulmonary complications are rare, and the patient leaves the operating room with a good steady pulse and a dry warm body, and—what is even more encouraging—he awakes from the ordeal fresh and anxious to co-operate in the post-operative ritual prescribed for him.

Many local anaesthetic agents have been advocated, but I prefer a 0.5 per cent solution of novocaine, of which from 200-400 cc. is injected for the abdominal field block and from 50-80 cc. for the splanchnic block. Adrenalin solution is not added to the novocaine as it may at times produce alarming toxic symptoms.

The technique is as follows: Five small circular intra-dermal wheals are made with a fine hypodermic needle, one over the xiphi-sternum and two at the outer border of each rectus muscle—one on each side near the tips of the ninth costal cartilages and one on each side at the level of the umbilicus (fig. 18 [1]). Through these wheals the upper abdominal block is carried out by infiltration of the skin and subcutaneous tissues along the costal margin over the lower end of the sternum in a fanwise direction and down the lateral border of the rectus muscle, after which the muscles themselves receive a generous dose of the anaesthetic solution (fig. 18).

When this injection is completed the surgeon should wait for at least ten minutes to allow the full anaesthetic effect to be produced before proceeding to make the abdominal incision. The parietal peritoneum when exposed is infiltrated, and after being freely incised each side is picked up with haemostats or drawn upward and outward with claw retractors so that its under-surface—or rather the loose cellular space which exists between the parietal peritoneum and the rectus muscles and which is richly supplied with sensory nerve endings—can be freely injected (fig. 18 [2]).

The stomach is then drawn gently downward and the gastro-hepatic omentum is anaesthetised, after which the index finger of the left hand slides cautiously upward over the pancreas toward the body of the first lumbar vertebra. The introduction of the tip of



FIG. 18.—TECHNIQUE OF LOCAL ANÆSTHESIA FOR GASTRIC OPERATIONS.

- (1) The five intra-dermal wheals are shown.
- (2) The parietal peritoneum is being freely infiltrated with the local anæsthetic solution.
- (3) The splanchnic region is being anæsthetised after the method suggested by Braun.

this finger pushes the anrta over to the left and the inferior vena cava to the right and comes to lie directly over the twelfth dorsal or first lumbar vertebra, which is separated from the finger only by periosteum, by the crura of the diaphragm, and by the stretched layers of the small omentum. Above, the fingers can be introduced no further, while below, the arching hepatic artery can be identified as a throbbing cord lying above the tough substance of the pancreas. A 12 to 15 cm. needle is now passed along this finger, which is kept steady until the point of the needle strikes the unyielding vertebra, when it is somewhat withdrawn in order to avoid injecting the periosteum or the tense ligaments of the crura (fig. 18 [3]). When once the point of the needle is in the correct position, the shaft should be firmly gripped with the fingers of the left hand and kept immobile while the syringe is being attached and while the solution is being injected into the loose retroperitoneal tissues of the splanchnic region.

It is best to use 20 cc. Record syringes almost filled with the novocaine solution and to aspirate before each 20 cc. is injected, to make quite sure that no blood is withdrawn into the syringe which would indicate that the inferior vena cava or some large adjacent vein had been punctured. If blood is withdrawn into the syringe, the needle should be reintroduced at a different spot. The fluid should be injected slowly, the average dose being about 60 cc., while for a large robust patient 80 cc. is a more appropriate dose. Anæsthesia becomes complete in five to ten minutes and lasts according to the amount and the concentration of the solution, varying from about one to one and one-half hours. The block is completed by running 10 to 20 cc. of the solution into the lax space which exists between the two leaves of the mesocolon.

At the completion of the operation the edges of the parietal peritoneum and the upper half of each rectus muscle are again liberally infiltrated with the anæsthetic solution so that the suturing of the individual layers of the wound can be accomplished without pain or tension. If, after the abdomen has been opened it is found impracticable to block the splanchnic nerves by Braun's method, the more simple "creeping" local analgesia of the omenta may be recommended.

When the anæsthetist has examined the patient and ordered the

premedication, he should, after consultation with the surgeon, choose the anæsthetic best suited to the patient's condition. During the operation it is wise for the anæsthetist to keep an accurate check on the pulse rate, respiration rate and blood pressure. Readings of these should be recorded at ten-minute intervals and reported to the surgeon when necessary. The anæsthetist should order appropriate combative measures when these are required in emergency, e.g., coramine, rectal saline, intravenous saline or blood transfusion, and he should also discuss with the surgeon at the completion of the operation the lines upon which the immediate post-operative treatment can best be conducted. It is strongly recommended that, if practicable, he should accompany the patient from the operating theatre to the recovery room or ward in view of the possibility of serious accidents occurring during transit.

Premedication. For many years patients have been given sedative drugs before operation with very beneficial results. For example, a suitable dose of omnopon and scopolamine will usually render him so somnolent that he loses his apprehension, whereas the anamnestic effect is such that he frequently remembers little or nothing of the induction of general anæsthesia. Recently the tendency has been to aim at more than mere "sedation" and to employ various drugs which will render the patient unconscious in his bed before his removal to the operating room. The drugs which produce this effect are termed basal narcotics. The following is a brief note on the principal pre-anæsthetic drugs in use for gastric operations, together with their dosage:

(a) *Omnopon and Scopolamine.* This is used very frequently today before the administration of most inhalation anæsthetics. The usual adult dose is omnopon gr. $1/3$ and scopolamine gr. $1/150$, this being injected intramuscularly at least one hour before operation is due to commence. This narcotic allays apprehension and may in some cases produce actual sleep or amnesia.

(b) *Paraldehyde.* This is probably one of the safest basal narcotics known and is administered per rectum made up with either normal saline, 1 drachm to the ounce, or dissolved in 6 oz. of olive oil. The usual dose is 1 drachm per stone (14 lbs.) body weight, but it is never advisable to exceed 8 drachms, and a wise precaution is to underestimate by some 4 to 10 lbs. the actual weight of the patient.

Paraldehyde causes a slight fall in blood pressure and also markedly depresses the respiration. Induction and recovery are usually quite tranquil, but on rare occasions restlessness may be a marked feature. Those in attendance often complain of the unpleasant smell, which is characteristic since the drug is partly excreted through the lungs. Premedication with paraldehyde is of great value when operating on children.

(c) *Avertin*. This drug is administered per rectum and must be freshly prepared by dissolving it in distilled water at a constant temperature of 40° C. and made up to a concentration of 2.5 per cent to 3 per cent. The solution must always be tested before use by adding a few drops of Congo red dye. The slightest change of colour toward blue is an indication that the solution is unsuitable for use. The average dose is 0.1 gm. per kilogram body weight, which can be quickly calculated from tables; but before assessing the exact amount to be given, the patient's age and general condition and the nature of the disease should be ascertained, because once the drug is introduced into the rectum it is rapidly absorbed and any overdose may have serious consequences. The solution has a characteristic smell. The drug causes a fall in blood pressure and depresses both respiration and the reflexes, and it is for these reasons that it cannot be freely advocated for gastric surgery.

(d) *Nembutal*. This is often given the night before operation to induce sleep, and again about one and one-half hours prior to operation. The usual adult dose is 3 to 4½ grs., i.e., two or three capsules. When given by mouth, nembutal cannot always be relied upon to produce deep sleep, although "sedation" and subsequent anamnesia are generally satisfactory. When given intravenously the freshly prepared solution is injected at the rate of 1 cc. per minute until the patient is unconscious.

(e) *Sodium Amytal*. This may be given by mouth or by the intravenous route, the usual dose being 3 grs.

(f) *Sodium Soneryl*. This drug administered orally is probably as dependable as nembutal; the usual adult dose is from 3 to 5 capsules, there being 2¼ grs. to each capsule.

(g) *Sodium Hebaral*. This is also given by the mouth in 3-gr. capsules. Its main advantage over the other barbiturates is that it is very rapidly eliminated.

(h) *Pernocton*. This is a stable solution and can be injected intravenously direct from ampoules. The average dose is from 4 to 5 cc., but not more than 1 cc. should be given per minute, in fact the slower the injection the safer it is for the patient. If the patient is already asleep before he has received the full quantity of the pernocton indicated, the injection should be discontinued. I have always found this drug to be most satisfactory, although it is very rarely employed nowadays, its use having been almost entirely superseded by evipan and pentothal sodium.

(i) *Evipan*. This is usually employed as a basal narcotic, but occasionally as a short general anæsthetic, e.g., for extraction of teeth, etc. The preparation used is a freshly made 10 per cent solution of the powder in sterile distilled water which is injected at the rate of 1 cc. in 15 seconds until consciousness is lost. It is the most useful method of producing complete narcosis prior to general anæsthesia and interferes to only a slight degree with subsequent general anæsthesia by prolonging the period of deep ether narcosis as it produces a preliminary depression of respiration. Owing to quick recovery to consciousness of the patients and speedy elimination of the drug it is certainly the method of choice for patients who are required to go to sleep in their beds.

The *contra-indications* to the use of evipan are: Cachectic patients; the feeble and very aged; where there is any degree of shock; low blood pressure; where during operation the Trendelenburg or reversed Trendelenburg position is to be employed; gross disease of the liver or kidney; inability to find a suitable vein into which the drug can be injected.

(j) *Pentothal Sodium*. One gram of the drug is dissolved in 10 cc. of sterile distilled water, and this is introduced into a vein at the rate of 1 cc. in fifteen seconds, a pause being made after the injection of 2 cc. to ascertain the general condition and reaction of the patient. If all is satisfactory, the injection can be continued at a slower rate until complete narcosis is produced. Anæsthesia is then continued by means of inhalation methods.

Pentothal sodium is usually reserved for minor operations, which can be performed entirely under its influence. It is definitely more potent and produces greater muscular relaxation and depression of respiration than evipan.

Prior to the administration of either evipan or pentothal sodium it is well to give a preliminary dose of omnopon, gr. $1/3$, and scopolamine, gr. $1/150$, at least one and one-quarter hours beforehand.

To summarise: of the foregoing pre-anæsthetic drugs for gastric surgery it may be said that nmnopnn and scopolamine is certainly the safest and generally the most effective, as it causes no fall in blood pressure and no marked respiratory depression and can be given prior to all types of anæsthesia, whether local or general. Evipan is perhaps the next most efficient, as it produces complete narcosis although not without a slight fall in blood pressure, which is quickly recovered from on detoxication. The respiratory depression is also of short duration. The same may be said of pentothal sodium, although with this drug the extra potency and more marked fall in blood pressure and respiration add in some degree to the difficulties of subsequent general or local anæsthesia. Avertin is a most comfortable and much-appreciated method of inducing anæsthesia, but causes a decidedly marked fall in blood pressure and very prolonged respiratory depression. Patients tend to remain unconscious for some hours longer, and are perhaps more inclined to develop chest complications owing to their inability to rid the air-passages of collecting mucus. Nembutal is a good and sound medium of premedication, but it possesses all the disadvantages of avertin in addition to an uncertainty in its action in producing complete narcosis.

Little further need be added as to the other drugs mentioned since they are rarely used and full satisfaction has been obtained from one or other of those just discussed.

ARMAMENTARIUM

Every surgeon has his favourite instruments, in fact some find it impossible to operate satisfactorily without them.

The following is a brief account of a few of the instruments employed by me for gastric operations:

(a) **Knives.** Bard Parker handles, No. 3 and Nn. 4, with No. 10, No. 15, No. 20, No. 21 and No. 23 blades are preferred to the ordinary scalpels. The Bard Parker blades are thin, strong, razor-like in sharpness, and inflict the minimum amount of damage upon the tissues.

(b) **Spencer Wells or artery forceps.** For brevity these will be described as hæmostats. Three sizes are commonly employed: (1) mosquito (Halsted's small slender with fine points): (2) short (Dunhill's): and (3) long (gently-curved on the flat, with tapering points, made by Arnold & Sons). All these instruments are made on stainless (rustless) steel and have large finger-rings.

(c) **Tissue forceps (Allis).** These will be seen in use in many of the illustrations (fig. 19).

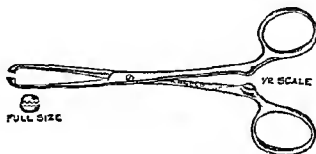


FIG. 19.—ALLIS FORCEPS.

(d) **Retractors (Deaver).** These are made in two sizes, large and small (fig. 20).



FIG. 20.—DEAVER RETRACTOR.

(e) **Tetracloths forceps.** Scott Ridout cross-action forceps do not damage the skin or subcutaneous tissues, lie snugly against the abdominal wall well away from the wound, and are simple to apply and to remove.

(f) **Electric cautery, diathermy knives, and suction tubes.** These are of various shapes and sizes so essential to smooth and tidy work that they must be readily available during all abdominal operations.

(g) **Clamps.** Small and large Payr crushing clamps should be at hand during the performance of all gastric operations. The De Petz clamp is a useful instrument in cases of gastric resection. It some-

what resembles a Payr enterotribe except that the upper blade is much larger, being adapted to hold a double row of fine metallic staples, and there is a ratchet by means of which the staples are forced through the tissues and turned over to seal off the crushed portion of the gut with a double row of clips before it is divided. The Friedrich-Petz clamp, which is more serviceable than the original De Petz clamp, carries the staples in separate magazines so that it can be used for several suture lines in succession (fig. 21). If the clamp

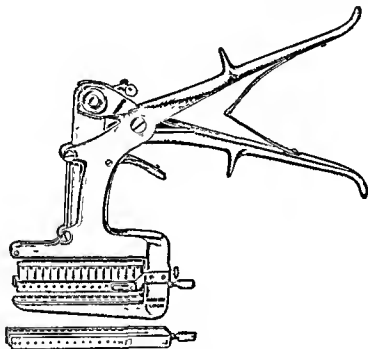


FIG. 21.—FRIEDRICH-PETZ CLAMP.

has been employed to expedite or facilitate resection of the stomach in cases of peptic ulcer, it is most important to trim away the crushed area with all its contained clips when the anastomosis is being performed, as disregard of this precaution undoubtedly predisposes to the formation of a secondary ulcer. In cases of partial gastrectomy for cancer some of the clips may be left in situ, and it is customary in such cases to cut away the lower half of the crushed groove with its clips and to use this portion of the stomach for anastomosis with the jejunum, the top half being invaginated into the gastric pouch. It is claimed that these tiny clips eventually slough out and that

as their ends are turned under they pass into the intestines and are discharged per rectum. While this may be true for some cases, the clips may, nevertheless, in others remain imprisoned in the tissues for many months, and being a constant cause of irritation or infection are likely to produce a chronic callous ulcer at the anastomotic junction. Their presence in the gastric wall may be demonstrated by means of X-rays as small metallic foreign bodies. I saw such clips clearly outlined in skiagrams which were taken to determine how the gastro-enteric stoma was functioning in a patient upon whom I had performed an anterior Polya partial gastrectomy for carcinoma of the pylorus five years previously.

Enterostomy clamps are still used routinely by many surgeons for gastro-jejunostomy and for restoring gastro-intestinal continuity after resection of the stomach. Perhaps the best types are those which bear the names of Moynihan and Sherren, as these have long strong blades which, when in use, should be ensheathed in soft rubber tubing. The occurrence of immediate post-operative hæmorrhage or of jejunal ulcer after gastro-jejunostomy is often unjustly attributed to the use of clamps, with the result that many surgeons have now entirely discontinued their use. If, however, they are used cautiously and gently and are applied by the surgeon himself in such a manner as to avoid any damage to the delicate mucosa and only partially to control bleeding from the cut surfaces from the parts to be anastomosed, if the suturing is conducted with scrupulous care, and if the grip of the clamps is released, first after the insertion of the posterior row of stitches and again just before the anterior row of stitches is completed, to ensure that the sutures do not miss any bleeding point, there will be no untoward result from their use; in fact, by effectively preventing soiling of the abdominal wound and abdominal cavity through leakage of gastric and intestinal contents, the likelihood of wound sepsis or peritonitis is prevented, and by bringing the portions of the stomach and jejunum into easy apposition the suturing is rendered safe, quick and simple.

Nevertheless, I do not use clamps: (1) For operations about the pylorus, *e.g.*, gastro-duodenostomy, as here they are a hindrance rather than an aid; (2) for cases of pyloric obstruction demanding gastro-jejunostomy, as the long-standing dilatation has rendered the stomach wall œdematous and friable to a marked degree, and the

pressure of a clamp may cause serious damage; or (3) for œsophago-jejunosomy following total ablation of the stomach, as here they are unnecessary and cumbersome. They are, furthermore, seldom required for the straightforward gastro-jejunosomy or for partial gastro-duodenal resection for duodenal ulcer.

Clamps should never be used unless they can be applied with ease; when there is any tension or stress it is best to dispense with them altogether.

EXPLORATORY LAPAROTOMY

Exploratory laparotomy is very rarely required in order to establish a diagnosis of destructive organic disease of the stomach or duodenum. Pyloric stenosis, extension of an ulcer to a size which precludes the likelihood of permanent healing, early cancerous change, and the presence of innocent tumours can be detected with much greater certainty by means of clinical methods, radiography, functional tests and gastroscopy than by inspection and palpation at operation.

But in spite of the great advances which have been made in diagnosing gastric and duodenal disorders, there are still a few baffling cases of organic disease which defy detection by these means but which, nevertheless, on account of the symptoms present, call for surgical measures. I refer particularly to certain cases of cancer of the stomach which present suspicious symptoms but in which on X-ray examination no abnormality is detected and in which the presence of growth cannot be confirmed even by the keen eye of the gastroscopist; to the rare ulcer of the duodenum abutting on the pylorus, which, in excavating the walls of the bowel, produces no discernible niche or distortion of the bulb on fluoroscopy but which is, notwithstanding, associated with teasing dyspeptic symptoms and mysterious bouts of hæmatemesis or melaena; to the elusive jejunal ulcer which is situated more than two inches away from a gastro-enteric stoma, and to chronic duodenal ulcers situated in the descending limb of the duodenum just proximal to the ampulla of Vater.

With these exceptions, however, it is almost invariably possible to arrive at a correct diagnosis, but where genuine doubt exists it is

better on the whole to adopt a conservative attitude than to resort to direct methods of surgical enquiry.

When operation is advised for chronic gastric or duodenal ulcer or for malignant diseases of the stomach it is often wise to conduct a very thorough routine examination not only of the stomach and duodenum but also of the remaining abdominal viscera. These are best investigated in the following order: Stomach and duodenum; liver, gall-bladder and bile passages; pancreas and spleen; duodeno-jejunal flexure and small intestine; appendix and cæcum; colon, and pelvic organs. The whole of the stomach and duodenum must be methodically examined. The anterior surface, the greater and lesser curvature, the omenta with their glands, and the cardiac and pyloric regions are palpated and visualised by good retraction, after which the posterior surface and the stomach bed are explored either through an incision made in the small omentum or preferably through a rent in the gastro-colic ligament. The four parts of the duodenum are examined seriatim, particular care being taken in palpating the hula, testing the patency of the pyloric outlet and the tone of the sphincter, searching for the bed of a hidden posterior ulcer, and noting scarring, distortion, narrowing, and thickening of the bowel, as well as the condition of the surrounding parts.

The first loop of jejunum is picked up and drawn through the wound to allow inspection of the duodeno-jejunal flexure in order to ascertain whether any congenital or inflammatory bands bind it to the mesocolon and to find out whether the large mesenteric blood vessels have in their upward course produced any constriction of the intestine which they override.

The transverse colon should next be drawn bodily upward to display the mesocolon and the arrangements of the vascular arches therein. If this supporting structure is fat-laden, short, or fixed to the upper coils of jejunum by inflammation or by congenital membranes, or if the blood vessels in it assume an eccentric distribution, it is unwise to incise it in order to draw the stomach or the uppermost jejunal coils through it for the purpose of making an anastomosis.

The liver is easily explored by slipping the hand over its exposed surface and palpating it to test its consistency.

The healthy gall-bladder is sea-green in colour and can be emptied of its viscid contents by gentle compression with the fingers, when its

walls will be found to be thin and elastic. Inspection and palpation will very rarely demonstrate disease which clinical investigation and X-rays have failed to reveal. It is impossible to detect a few elusive, small, shot-like calculi in a normal-looking gall-bladder which is tense with bile, unless the viscus is first milked dry. The signs of chronic cholecystitis are unmistakable; the walls of the gall-bladder are found to be thicker and firmer than normal, the sea-green colour is toned down by shades of grey, the subserous fatty tissue is augmented, the cystic lymph gland feels prominently enlarged and slotty, and inflammatory adhesions drag up the colon with its omenta and shut off the area in preparation for a future crisis.

The common bile duct is next noted, and palpation is carried out with a finger thrust into the foramen of Winslow, while the thumb compresses the structures which lie in the free outer border of the gastrohepatic omentum. The index finger and the thumb sweep upward and downward in their search for stones, enlarged glands, etc., an attempt also being made to gauge the calibre of the main ducts.

The pancreas and spleen in turn receive attention before the small intestine, the cæcum, and the ever-guilty appendix are examined.

The colon is palpated for growth or diverticulitis, after which the pelvic organs and the pelvic shelf are systematically and deftly explored with the fingers.

It would be wrong to assume that such a searching investigation of the viscera is required in every case, and under the following conditions it would be even meddlesome and injurious:

(a) In cases of infantile pyloric stenosis. Here only the pyloric tumour is sought for and dealt with by Rammstedt's operation.

(b) Where it is deemed advisable to perform gastrostomy, e.g., for impassable malignant stricture of the œsophagus. Here only a cone of the anterior wall of the stomach is withdrawn through a small vertical incision below the costal margin.

(c) In cases of perforated peptic ulcer. Here, after the perforation has been located and sutured, a rapid examination of the entire stomach and duodenum is carried out, as on rare occasions coincidental multiple perforations are encountered.

(d) In those cases where operation is advised on account of severe bleeding from a chronic peptic ulcer, as here exploration of all the

abdominal viscera would unduly protract the operation and increase shock.

(e) In dehydrated and toxæmic patients suffering from a severe degree of dilatation of the stomach due to a cicatrising duodenal ulcer. Here an expeditious short-circuit operation is performed with the minimum amount of disturbance of the viscera.

PRE-OPERATIVE TREATMENT

"Surgery has been made safe for the patient; we must now make the patient safe for surgery" (Moynihan).

All patients with organic gastric or duodenal lesions who are admitted to hospital under the care of the surgeon for operative treatment must undergo a course of pre-operative medication, the length and nature of which will vary with individual cases. No patient should be refused the benefit of operation because he is deemed to be a bad surgical risk. The majority of these cases are indeed bad surgical risks, since many of them are the derelicts of inadequate medical therapy and many are dehydrated from protracted vomiting, emaciated by stringent diets, pale or lemon-coloured from loss of blood, discouraged by prolonged disability, or melancholic through having long harboured the sinister thought that at operation an irremovable and widespread cancer will be found.

The surgery of peptic ulcer deals only with the complications which have arisen, while the surgery of cancer of the stomach is reserved solely for the brave. While these patients are awaiting this the sternest ordeal of their lives, we can do much for them by gaining their confidence, by making them comfortable in surroundings that are pleasing to them, by achieving the maximum improvement in their condition in the minimum of time without taxing their strength unduly, using simple rather than complicated methods, and by convincing them that we are working wholeheartedly on their behalf.

In the average case of peptic ulcer, when the patient's condition is fair it is best to admit him to hospital two or three days prior to operation in order to conduct further investigations if this is deemed advisable and to accustom him to his surroundings while the routine pre-operative ritual is being carried out. He should not be kept constantly in bed, in fact it is better for him to be up and about for a

part of the day in order to maintain muscular and circulatory tone and pulmonary ventilation and to prevent his mind from dwelling unduly upon the thought of his pending operation. A nutritious semi-solid and non-residue diet and a liberal supply of vitamin A or C is prescribed, together with the usual medicines which are employed in the treatment of chronic peptic ulceration. In addition to this, large quantities of fluids and glucose are given to stimulate renal excretion, to guard against dehydration and to ensure an adequate supply of glycogen in the liver and muscles.

The night before operation a light meal is ordered, and at the hour of retiring a sleeping draught, such as medinal grs. 10, sodium amytal grs. 3, or the like, is given. This will usually ensure peaceful sleep, and the patient will wake in the morning fresh, rested, and ready to face all that has to be done in the two hours or so which remain before the operation is due to start.

The abdominal field should be prepared and a sterile dressing applied; the teeth and gums should be cleaned, and dentures (if any) removed; the lower bowel should be washed out with plain water; the stomach should be irrigated with normal saline, and its contents evacuated by aspiration; the patient should be instructed to pass water and if unable to do so he must be catheterised. He should also be visited by the anæsthetist just before the pre-anæsthetic drug is administered.

It should be a routine practice to pass a small stomach tube and aspirate the gastric contents of all patients shortly after admission and again two hours before operation. When gastritis is marked or when obstruction is present, frequent gastric lavage with normal saline or dilute hydrogen peroxide is essential. In cases of gastric ulcer a certain degree of gastritis is always present; in cases of long-standing pyloric obstruction due to a stenosing duodenal ulcer, gastritis and dilatation go hand in hand—the greater the dilatation the more pronounced the gastritis—and here it is often common to find complete absence of hydrochloric acid in the gastric juice. When the tenacious mucus is removed from the stomach by irrigation and aspiration, when the inflamed mucosa is afforded the rest that it needs, and when it is protected and soothed by drugs, the return of acid is a token of successful therapy.

In the immediate pre-operative stage purgation, like starvation,

is a potent factor in producing acidosis, dehydration and gaseous distress. If the patient is in the habit of having a normal daily evacuation of the bowels, no purgatives are indicated; but it is usual to give a rectal wash-out of plain water at least two hours before he is removed to the operating room. When, however, constipation is a marked feature, an attempt should be made to clear the bowel thoroughly the day before operation by means of a full dose of liquid cascara evacuant or by the aperient the patient is in the habit of taking, plus a turpentine enema; but he is in no sense of the word freely purged. Repeated enemata are to be deprecated as they are responsible for a great deal of the intestinal distension seen both during and after operation.

When the patient has a large penetrating lesion—one that has breached all the coats of the stomach or duodenum and has deeply pitted the pancreas or liver, when he is exhausted from pain and loss of sleep, and when he shows evidence of dehydration and emaciation through his abstention from food and fluids, a much longer course of pre-operative treatment is required, extending in some cases over several days or possibly weeks. He must be confined to bed altogether with complete rest and quiet, sleep being ensured by the administration of sedative drugs. Pain must be relieved by giving belladonna, morphia, alkalis and olive oil, and a strict ulcer diet, such as Hurst's, is ordered. The stomach should be thoroughly washed out once or twice a day with warm physiological saline in order to remove mucus or any decomposing gastric contents. The reservoirs of the tissues should also be flushed out with fluids introduced orally, rectally, intravenously or subcutaneously.

Frequent examinations of the blood, of the aspirated gastric juices, and of the stools will be necessary during this period to gauge the efficacy of the treatment instituted. It is common to find that a marked general and local improvement has accrued, even after only a few days of the treatment detailed above. Considerable absorption of the inflammatory products in the vicinity of the ulcer will take place, gastritis will be diminished, and even a large, previously fixed and apparently irremovable ulcer may be rendered resectable by these measures.

If there is marked anæmia from continued loss of blood, blood transfusion will be necessary, and in such cases operation should be

deferred until the patient is in a fit condition to withstand it. During the preparatory period a mixture containing iron and arsenic is also given.

Obstruction and retention from organic lesions is one of the most important pre-operative considerations. When there is prolonged organic obstruction the stomach slowly becomes dilated and atonic and there is in addition a diffuse gastritis accompanied by a decrease in the units of free hydrochloric acid. Vomiting of large quantities of putrid, semi-digested food and evil-smelling fluid soon ensues, and the patient becomes dehydrated, emaciated and toxæmic.

Brown, Eusterman, Hartman and Rowntree (*Arch. Int. Med.*, 32:425, 1923) accurately describe the syndrome and blood chemical changes in such cases, and McVicar (*Minnesota Med.*, 8:429, 1925) has shown how the blood chemical factors run parallel with the clinical condition of the patient.

It is very important to examine the blood in all cases in which there is the least degree of retention in the stomach, to determine the content of chlorides, the non-protein nitrogen, and the CO_2 combining power of the plasma. In this way comparatively mild cases of toxæmia can frequently be discovered before the symptoms have become definitely established. The size of the stomach should be determined by fluoroscopy, both at the start of the pre-operative treatment and also at the end of five or six days when the maximum improvement is to be anticipated. Shrinkage of the viscus would indicate a return to healthy muscular tone, that obstruction has been successfully overcome, and that the propitious moment for surgical intervention has arrived. Thus the objects of pre-operative treatment are: To reduce the size of the dilated stomach and also to correct the metabolic disturbances occasioned by the obstruction. The former is achieved by gastric aspiration and lavage, either by passing a tube once or twice a day as may be indicated, or by means of Wangenstein's method. The patient should be urged to drink as much fluid as possible to aid in the lavage and cleansing of the stomach, but such treatment, of course, should not be carried to dangerous extremes, as continued aspiration causes a further depletion of blood chlorides through loss of gastric secretion. This loss should be compensated by means of intravenous injections of 5 per cent glucose in normal saline, about 3,000 to 5,000 cc. being introduced daily by

the slow drip method or by feeding the patient by the continuous milk drip method through an indwelling duodenal tube when this has been employed. In addition to this an acid mixture containing dilute hydrochloric acid is given orally three or four times daily. No solid food is permitted during the pre-operative period. Blood transfusion often has a remarkably beneficial effect and is advised for all severe cases, irrespective of the degree of toxæmia present.

As stated before, frequent estimation of the blood chlorides and CO_2 combining power of the blood plasma is made and treatment modified according to the results obtained.

Tetany is always associated with severe alkalosis and is an indication of marked disturbance in the acid-base mechanism. McVicar states that tetany may be anticipated when the CO_2 combining power exceeds 100 per cent by volume. The painful muscular spasms which occur can be partially relieved by intravenous injections of 10 cc. of calcium gluconate combined with occasional intramuscular injections of morphia and atropin.

The optimum time for operation in these cases is decided by the return of laboratory findings to normal, an all-around improvement in the patient's general condition, and the degree of reduction in the size of the stomach. It is rarely necessary to prolong the pre-operative treatment, as outlined above, for more than one week.

It should be noted here that for patients with chronic peptic ulceration the eradication of all accessible foci of infection constitutes an important part of the pre-operative treatment. The nose, accessory sinuses, tonsils, teeth and gums should always be carefully examined, and if any septic focus is found it should be dealt with. No gastric operation should be performed shortly after the enucleation of tonsils or after the wholesale extraction of teeth, but ample time, often amounting to as much as a month, should be allowed for healing to take place. If, however, the patient is suffering from an operable cancer of the stomach or through lack of response to medical treatment his condition is desperate and the obstruction demands immediate relief, the removal of such foci must be deferred until he is convalescent from his operation.

It should be remembered that there are at least two other likely sources of infection: the appendix and the gall-bladder. Therefore during the performance of an operation for peptic ulcer the appen-

dix (when present) should if possible be removed, and the gall-bladder, if found to be diseased, should also be excised whenever circumstances permit.

The course of pre-operative treatment prescribed for patients with cancer of the stomach should be reduced to the minimum time, the essential lines of treatment being as follows:

(a) The patient should be admitted to hospital three or four days before operation.

(b) Large quantities of fluids, glucose and cream are given by mouth, but no solid food.

(c) Daily gastric lavage should be done, using a 0.25 per cent solution of hydrochloric acid or normal saline. The stomach is freely irrigated two hours before operation.

(d) Intravenous Hartmann's solution, about 3,000 cc., and small blood transfusions, about 300 cc., are also given, both daily and during the operation itself, especially when the concentration of hæmoglobin is less than 50 per cent.

(e) Sedative drugs are prescribed to produce sleep and to alleviate pain.

(f) Vitamin C is given in the form of redoxon or fresh lemon or lime juice.

POST-OPERATIVE TREATMENT

Many schemes have been adopted by various surgeons in their management of cases after the performance of major gastric operations. The main principles of such treatment are, however, much the same in each and may be briefly outlined as follows:

First Day. When the patient returns to bed he is placed in a slight Trendelenburg position so as to prevent the aspiration of any regurgitated gastric fluid and in order to facilitate the removal of all bronchial secretions. As soon as he has regained consciousness he is placed in a half-sitting position, while a little later Fowler's position is adopted. On full recovery from the anæsthetic, morphia, gr. 1/6, or omnopon, gr. 1/3, is injected, and one or other of these drugs is repeated as often as is required, although not more than two injections during the first twenty-four hours are usually necessary. Body heat is maintained by providing a warm bed and dry clothing, and by means of applications of mild radiant heat, electrically heated

blankets, hot water bottles, etc. Cardiac stimulants, such as coramine or digitalis, may prove needful, while the following mixture given hypodermically 6-hourly for four doses may also be found useful:

Liq. adrenalin hydrochlor., 1/1000, minims 10.

Strychnine hydrochlor., gr. 1/50.

Atropine sulph., gr. 1/200.

The patient may vomit once or twice when regaining consciousness (anæsthetic sickness), but frequent vomiting, which is very rare, is a cause for some uneasiness. When it occurs, a small stomach tube, such as Ryle's, should be passed through the nostrils into the stomach and the gastric contents aspirated, this being followed by very gentle irrigation with warm physiological saline solution. If the vomiting is persistent, the tube should be passed at frequent intervals or be left in situ so that the aspiration and irrigation can be carried out as often as is required.

Since adopting the practice of giving fluids freely by mouth immediately after major gastric operations, I have found vomiting of a troublesome nature to be singularly absent. When fluids are taken in this way they relieve the insatiable post-anæsthetic thirst, render the tongue and mouth moist and clean, flush out the stomach and rid it of much decomposing blood, and their use is not followed by any untoward effects such as ileus. It is the natural way of giving them and nature prefers to absorb fluid from the small intestine rather than from the rectum or from the ill-adapted subcutaneous tissues. The patient may therefore drink as much water, barley water, glucose water or weak tea as he desires.

Intravenous injections are very rarely required for the average case, although they may be indicated for feeble patients, for those who are suffering from shock, or for those who show a sluggish return to consciousness. Here a minimum of 2,000 cc. of normal sodium chloride should be given to an adult during the first twenty-four hours after operation. Following wide gastric resections for cancer and after operations upon anæmic, aged, emaciated or toxæmic patients, blood transfusion is helpful.

During the first twelve hours after operation, inhalations of CO₂ and oxygen are given for a few minutes every hour to hyperventilate the lungs and to encourage deep breathing. In the presence of anox-

æmia or when this condition is even suspected, oxygen in large quantities is indicated. Recently some doubt has been cast upon the advisability of giving CO_2 inhalations or, rather, upon its aggressive use on the operating table immediately after operation. It is stated that if there is much bronchial secretion a quantity of mucus may be forcibly sucked back into the bronchioles during the exaggerated respiratory movements that are caused by the CO_2 inhalations and this may lead to a massive collapse of the lung.

Second Day. As a rule only one injection of morphia is required, a sleeping draught being prescribed toward the close of the day to ensure sound sleep. The administration of fluids by mouth or intravenously is continued according to the patient's condition. If he is well enough, he is allowed to drink liberally. If too weary to make the effort, a vein is chosen.

A rectal stasis tube is passed from time to time, but no purges or enemata are given on this day. If there is any difficulty in passing water, esmodil, 1 cc. hourly for three doses, is injected, and if flatulence or colicky pains are troublesome, 10 cc. of calcium gluconate are given intravenously for two doses, and pituitrin, 0.5 cc., subcutaneously hourly for four doses.

The binder and dressings should be inspected and adjusted. Deep breathing exercises and graduated movements of the limbs, which minimise the risk of pulmonary embolism and which encourage circulatory tone, are commenced and continued daily under the nurse's supervision, say, for five minutes every hour while the patient is awake.

Third Day. A glycerine enema is given and this is repeated daily until the bowels are working satisfactorily with the aid of paraffin and cascara or some other suitable aperient. No solid food is permitted until a good bowel action has been obtained and until all gaseous distension has disappeared. Bromide and aspirin mixture may with benefit be prescribed instead of the morphia injections, and this can be continued for the next two or three days.

Fourth Day. If the bowels are working satisfactorily and there is no evidence of distension, a light non-residue diet is ordered. Where partial gastrectomy has been performed for gastric ulcer or for carcinoma, no special diet is needed and feedings are increased cautiously until about the fourteenth day, when the patient is allowed a full

ward diet. After gastro-enterostomy or partial gastrectomy for duodenal ulcer, however, greater caution is required owing to the fear that indiscretions in diet may lead to the formation of a jejunal ulcer at a later stage. For these latter cases therefore the Lenhartz diet (see below) is prescribed, and this is continued for fourteen days, the patient also being given an alkaline mixture three times a day and being warned not to smoke or to take alcoholic beverages. During the convalescent period all patients are given ferrous salts, arsenic, stomach, or liver extracts, and a sufficiency of essential vitamins in the most palatable and convenient form to combat chiefly that much exaggerated and discussed bogey—post-operative anæmia.

MODIFIED LENHARTZ DIET

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Eggs	1	1½	2	2½	3	3½	4	4	5	5	5	2	2	2
Milk, to make, oz.	5	7½	10	12½	15	17½	20	25	25	25	25	25	25	25
Glaxo, or milk and water, oz. (equal parts)...	5	7½	10	12½	15	17½	20	25	25	25	25	25	25	25
Lactose, drms. ...			6	6	8	8	12	12	14	14	14	14	14	14
Plasmon, drms. ...					2	3	3	3	3	3	3	3	3	3
Blancmange, oz. ...							3½	3½	7	7	10	10	10	10
Rusk, oz.								¾	1½	2	2½	3	4	
Pounded fish, oz.								2	2	2	2	2	2	2
Butter, oz.									¾	1	1½	1½	1½	
Quantity given, oz. at each feed ..	1	1½	2	2½	3	3½	4	5	5	5	5	5	5	5
Caloric value (approximately)	160	210	400	475	580	685	825	1115	1185	1630	1820	2010	2080	2200

Water, 1 oz. may be given in between feeds after the third day.

Feeds are given 2-hourly by day, 1 hourly by night, ten feeds in the 24 hours.

Before the patient goes home he is given detailed instructions as to the medicines he should take and the food he should eat. He is also advised to follow a programme of moderation in all things, and is handed a copy of the following instructions (Hurst's) which he should consult frequently.

HURST'S POST-OPERATIVE REGIME

Avoid alcohol except, if desired later on, a small quantity of light wine or diluted whisky at meals. Avoid effervescent drinks and coffee.

Avoid all pips and skins of fruits, nuts, and all unripe fruit. For example, an orange may be sucked but not eaten. Currants, raisins and figs are particularly undesirable. Avoid all raw vegetables, whether taken alone (celery, tomatoes, cucumber, watercress), or in pickles and salads; green vegetables

must be passed through a sieve and mixed with butter in the form of a puree. Porridge is only allowed if made with the finest oatmeal.

Avoid vinegar, lemon-juice, sour fruit; fried fish; pepper, mustard, curry, chutney, excess of salt; new bread; tough meat; pork, made-up and fried dishes, high game, clear and thick meat soup.

Take plenty of butter and cream.

Eat slowly and chew very thoroughly. An adequate time should be allowed for meals, and rest for at least a quarter of an hour before and after meals. Meals must be punctual.

No smoking is allowed.

A feed should be taken in the middle of the morning, on going to bed, and again if awake during the night, in addition to breakfast, lunch, tea and dinner.

A teaspoonful of an "alkaline powder" (the "alkaline powder": 5 parts of prepared chalk with 1 part of light oxide of magnesia) in a little water should at first be taken an hour after meals, but subsequently only when there is indigestion or heartburn.

The bowels should be kept regular by means of the magnesia in the alkaline powder, and, if necessary, liquid paraffin; but no other aperients should be taken.

Have the teeth attended to every six months.

If there is the slightest return of symptoms, go to bed on a strict diet and consult the doctor; do not wait for the symptoms to get serious.

CHAPTER 9

DUODENAL ULCER

It is becoming customary to class gastric ulcer and duodenal ulcer together as one disease, and it is true that they have certain features in common in that their causation is probably the same, the methods employed for their diagnosis are identical, and the early signs and symptoms presented by the two conditions are in many respects similar, as are also the medical measures advocated for their treatment. It is thus quite impossible to discuss one disease without constantly referring to the other, and from many points of view they may be considered as being allied affections—peptic ulceration.

On the other hand, the risk of malignant transformation, the degree of morbidity, the potentialities of disaster, and the associated economic disturbance are factors which differ widely according to whether they are associated with duodenal ulcer or with chronic ulcer in the stomach. Furthermore, the surgical treatment of the two conditions varies in many essential details, and it is for this reason in particular that I propose to discuss them separately.

VARIETIES OF DUODENAL ULCER

Duodenal ulcers may be: (1) acute; (2) sub-acute, or (3) chronic; all being in the first instance acute.

Acute Ulcer. In the proportion of 3:1, acute ulcers are commoner in females than in males, and in the stomach than in the duodenum. No age is exempt, and although occasionally seen in infants (melena neonatorum) the condition is rare before puberty and occurs most frequently between the ages of 20 and 30, having a rising incidence later in life after the age of 50, owing to its frequent association with septic conditions and malignant disease. It is seen in conjunction with a separate chronic ulcer in only 4 per cent of autopsies, but in life the incidence is undoubtedly higher and may, as Hurst has intimated, be as much as 10 per cent. Acute ulcers are more often associated

with chronic ulcers in the duodenum than in the stomach, although, as stated above, when chronic ulceration is absent they are more often found in the stomach. They almost invariably accompany cancer of the stomach and may be a primary cause of severe hæmatemesis. They are usually multiple, but when single they are found more frequently in the duodenum than in the stomach.

The size and shape of acute ulcers show a wide variation. They may be round, oval, triangular, polyhedral, crescentic or linear. The majority are minute in size, being barely visible to the naked eye, while others may be as much as a centimetre or more in diameter. They may attack any part of the duodenal bulb, the region of the lesser curvature, or the pyloric segment. It is exceptional for acute ulcers of the stomach and duodenum to co-exist, as has been shown by Hurst and Stewart (*Gastric and Duodenal Ulcer*, 1929) who found that in a total of 151 cases ulcers were present in the stomach alone in 111, in the duodenum alone in 34, and in both organs simultaneously in 6.

Acute ulcers arise from a variety of causes, but one of the main factors in their production is damage to or devitalisation of the mucous membrane as a result of an acute infective or toxic condition, necrotic areas becoming digested by the gastric juice, leading to the formation of acute ulceration. The majority of cases heal spontaneously in the course of a few days, but others persist until eventually a sub-acute or a chronic ulcer forms. The factors which influence the production and healing of acute ulcers are persistence of sepsis, hyperacidity, gastric or duodenal stasis, and inadequate medical treatment.

On microscopic section an acute ulcer appears to be punched out of the mucous membrane, has sharp, well-defined edges, and a base which is covered with altered blood or bile. Oedema and slight congestion may be observed in some specimens, although usually there is no inflammatory reaction to be seen around the ulcer. A characteristic feature of an acute ulcer is that the mucous membrane is healthy right up to the margin of the cavity. There may be penetration of the submucosa or possibly of some of the superficial fibres of the muscularis, but even where there is a breach of the muscular layer there appears to be no appreciable reactionary inflammatory change. The submucosa is not thickened nor is there any evidence of granulation tissue in the base of the crater. The ulcerative condi-

tion may extend laterally at the expense of the mucosa, producing huge shallow ulcers, or may penetrate the muscular coats by a process of progressive sloughing and give rise to the typical terraced or cone-shaped ulcer.

Acute ulcers are prone to erode the arterioles and cause hæmorrhage, sometimes of a very severe, almost cataclysmic, nature, while occasionally they may perforate all the coats of the gut—acute perforated peptic ulcer. Here, unless the hole is closed without delay, peritonitis will speedily develop.

Most acute ulcers heal completely without leaving any visible scar. Where, however, there has been destruction of the muscularis, there will, on healing, be a small, puckered, stellate scar, visible only from the mucous aspect. Relatively few acute ulcers persist and become chronic.

Acute ulcers *per se* give rise to no typical diagnostic signs and symptoms during life, except when such complications as perforation or hæmorrhage occur. They may occasionally be associated with chlorosis, in which case they are often accompanied by epigastric pain, nausea, general weakness, and hæmatemesis (gastrostaxis). But while at operation a widespread weeping or generalised oozing of blood from the gastric or duodenal mucosa is seen rather than discrete ulceration, chlorosis as a clinical entity has now practically disappeared owing to improved modern hygienic developments.

The treatment of acute ulcers is medical, and except in the presence of perforation or intractable bleeding, operation is never advised.

Sub-Acute Ulcer. The sub-acute ulcer is a compromise between the acute and the chronic, and marks an intermediate or transitional stage between the two forms. An ulcer will become sub-acute when it persists for some weeks and extends in size and in depth instead of healing.

Chronic Duodenal Ulcer. Incidence. Chronic ulcer is a common disease, as has been evidenced by post-mortem reports from several countries, by surgical records, by clinical and X-ray examinations of patients suffering from dyspepsia, and by the analysis of a large series of cases admitted to general hospitals. It would appear almost impossible to arrive at a true and accurate assessment of the incidence, but the various estimates are instructive in showing:

1. That peptic ulcer patients are increasing in number from year to year.
2. That in general hospitals the admission rate is about 1.5 per cent.
3. That a study of autopsy material shows an incidence of 2 to 12 per cent.
4. That the findings in favour of ulcer are positive in from 10 to 24 per cent of dyspeptics when such patients are investigated by means of X-rays.
5. That peptic ulcer is one of the most frequent intrinsic organic causes of chronic recurrent dyspepsia.
6. That duodenal ulcer accounts for the majority of gastric operations performed at the present time.

Numerous *necropsy investigations* as to the frequency of peptic ulceration have been conducted with results which show an incidence varying from 2 to 12 per cent. Hart (1918) found open peptic ulcers or scars of healed ulcers in 12 per cent of the 3,058 autopsies of all diseases (adults only) investigated by him; Stewart (*Brit. M. J.*, 2:1021, 1923) found healed scars or chronic gastric and duodenal ulcers present in about 10 per cent of 4,000 post-mortem examinations conducted at Leeds; Hurst and Stewart (*Gastric and Duodenal Ulcer*, 1929) reported scars in 5.75 per cent of cases; while Robertson and Hargis (*Med. Clin. N. Am.*, 8:1065, 1925) found that of 2,000 post-mortem examinations there was evidence of healed or active ulceration in 237 (or 11.85 per cent). Present (*Ann. Surg.*, 108:32, 1938) has recently shown that among 2,395 consecutive autopsies studied by him, 174 (or 7.2 per cent) showed peptic ulcers. Sturdevant and Shapiro (*Arch. Int. Med.*, 38:41, 1926), on the other hand, noted that only 2 per cent of 7,700 necropsies revealed gastric or duodenal ulcers.

Albrecht (1930) investigated a group of chronic dyspeptics by means of X-rays and found that 24 per cent of the patients had peptic ulcers, while in a group of similar cases Percy and Beilin (1934) found 19.2 per cent. Bull (1936), working at the Southend General Hospital, analysed a consecutive series of 1,438 cases referred to him for radiological investigation with supposed disease of the stomach or duodenum with the following results: negative 988; gastric ulcer 116; duodenal ulcer 214; carcinoma 55; gastro-jejunal ulcer 7; ob-

struction of outlet of stomach 4; duodenitis 13; duodenal diverticula 12; gastric diverticula 2; pyloric hypertrophy 1; and indeterminate 26. He reported many of the indeterminates as having "inconstant irritability of the duodenal cap, due possibly to duodenitis or even to an erosion type of duodenal ulcer without crater."

Eusterman and Balfour, in their superb monograph, write:

In a period of 12 months a review of 15,985 patients undergoing roentgenological examination of the stomach because of digestive disturbance, reveals that 2,017 (or 12.2%) had deformities of the duodenal cap characteristic of duodenal ulcer. Only a little more than 1%, or 167 of these 15,985 patients, had roentgenological evidence of a gastric ulcer. In 24 cases there was roentgenological evidence of the presence of both a gastric and a duodenal ulcer in the same individual. This proportion between the different types of lesions has remained about the same for a considerable period, but in more recent years the incidence in the Clinic of duodenal ulcer apparently has been increasing, whereas the number of gastric ulcers, confirmed by roentgenological examination, has relatively diminished.¹

Surgical statistics do not reveal with any degree of accuracy the incidence of duodenal ulcer or its frequency in respect to other lesions within the abdominal cavity. But, as Balfour has pointed out, such figures do certainly represent as accurately as possible the frequency of lesions in which surgical measures have seemed advisable. He has shown that on this basis the ratio of duodenal to gastric ulcer to gastric carcinoma is about 12 : 1 : 3, but states that this ratio varies considerably in different countries.

Age Incidence. Ulcers are rare in childhood and adolescence, the majority occurring in adult life, chiefly between the third and fifth decades. As a rule, judging by the age at which they come to operation, gastric ulcer patients are slightly older than those with duodenal ulcer. Balfour (*Collect. Papers Mayo Clin.*, 19:129, 1927) found the average age of patients operated upon for gastric ulcer to be 47 years, for duodenal ulcer 43, whilst the average age of the onset of symptoms was 39 years for gastric ulcer and 32 for duodenal ulcer. It is quite a common experience to find patients with symptoms dating back over ten to fifteen years or even more, who on careful interrogation give a history of attacks of indigestion and other intestinal symptoms suggestive of the presence of ulcer occurring in adolescence.

¹ Eusterman and Balfour, *The Stomach and Duodenum*, 1935. Courtesy of W. B. Saunders Co.

Sex Distribution. A study of a large number of reports shows a preponderance of male patients in both gastric and duodenal ulcer groups. In summaries which group all cases as "peptic ulcers" the ratio of males to females varies from 1.1 : 1.0 to 4.8 : 1.0. In Present's series of 1,460 cases the ratio for all cases was 3.5 : 1, being 3.7 : 1 in the gastric and 3.5 : 1 in the duodenal cases.

Occupation and Types of Individual. No particular occupation appears necessarily to predispose to duodenal ulceration, although the incidence seems to be greatest among the professional classes, the Services, among athletes, and among those who while at work are subjected to undue mental or physical fatigue, to worry, or to extremes of temperature.

Hurst (*Guy's Hosp. Rep.*, 171:450, 1921) was the first to describe two distinct constitutional types of stomach and individual—the gastric ulcer type and the duodenal ulcer type. He termed these respectively the hyposthenic gastric diathesis and the hypersthenic gastric diathesis. Patients with the hyposthenic gastric diathesis are usually feeble and in comparatively poor health, having long J-shaped stomachs reaching to the pelvis (gastroptosis) and possessing in comparison with the duodenal ulcer type a diminished gastric motility and less potent gastric juice. These patients are more prone to develop gastric ulcer. Hypersthenic cases are generally men of the vigorous, intellectual, emotional, "go-get" type, in whom the stomach is small, transversely placed, steer-horn in shape, and marked by rapid emptying and an excess of free hydrochloric acid.

Although this latter type of stomach is compatible with good health and sound digestion, where in addition there is an impairment of the vitality of the mucous membrane, the supreme factor in the production of an ulcer is ready to hand and it is only when these conditions are present that a duodenal ulcer can occur. A gastric ulcer is never seen in the steer-horn type of stomach unless certain complicating factors, such as organic pyloric stenosis or chronic duodenal obstruction, are present. A definite family history of peptic ulceration is found in about one-third of all ulcer cases.

Racial Distribution. The incidence of peptic ulcer varies in peoples of different races, and it would appear in the main to be much commoner in highly civilised peoples. It is particularly prevalent in Britain, in European countries, in North America, and in the South

of India, and is rare in certain other countries, notably in China and in some districts of North India.

Somervell and Orr (*Brit. J. Surg.*, 24:227, 1936), in accepting McCarrison's views, are of the opinion that a diet deficient in vitamin A, by lowering the defences of the gastric mucosa, leads to an invasion of it by bacteria and a consequent chronic gastritis and duodenitis. The rupture of small abscesses in the lymph follicles gives rise to ulcers which, if continually irritated by a highly spiced diet, refuse to heal and become chronic.

ÆTIOLOGY

A general survey of this subject is necessary since our methods of treatment are based upon the acceptance of certain facts relating to the origin and chronicity of peptic ulcers. All clinical and experimental evidence shows that there are two factors which are simultaneously at work in the production of ulcers.

The *primary or initiating factor* of local trauma or necrosis of the mucous membrane, whether mechanical, thermal, septic or from infective emboli, from bacterial or non-bacterial toxins, from neurotrophic disorders, or from a lack of essential vitamins in food.

The *secondary factor* is comprised of the eroding digestive and irritant powers of the gastric juice, rich in free hydrochloric acid, which are responsible for maintaining the lesion.

One essential fact seems to emerge, *i.e.*, that although there may be one or more primary factors at work which may be held responsible for the initiation of the ulcer, once this has developed it can only thrive or remain chronic in the presence of free acid. It is the acid factor therefore which must receive our primary consideration when treatment is instituted.

Primary Factors.—*Mechanical or Thermal Trauma.* The mucous membrane along the lesser curvature is thinner and more firmly adherent to the underlying coats of the stomach than elsewhere. It is therefore less able to adapt itself to the variations in the size and shape of the stomach, and as the main traffic route (*Magenstrasse*) for food—so often unduly hot, coarse and bolted—is along the lesser curvature, it will be more likely to be subjected to trauma than other parts. Likewise, the anterior and posterior walls of the duodenal bulb

—the so-called ulcer-bearing area of the duodenum—receive the full brunt of the acid gastric chyme which is forcibly ejected through the pylorus during digestion. It is not uncommon to find an ulcer opposite the constriction in cases of diaphragmatic hernia, or under tense peri-gastric adhesions.

In further support of the trauma theory, many cases of ulcer have been reported following shortly after injury by direct violence to the epigastrium, *e.g.*, by a kick.

Bacterial Infections and Toxins. In certain cases the initial lesion in the mucosa is produced by bacteria or toxins. It is well known that the toxæmia of acute infections may give rise to acute ulcers and that acute ulceration is frequently noticed in cases of severe sepsis such as that which accompanies general peritonitis, acute suppurative appendicitis, septicæmia, extensive burns, etc. In the majority of cases the infection is blood-borne, although in some instances the swallowed organisms from infected guns or tonsils may play a small part in perpetuating ulceration, especially when gastritis is very marked.

Rosenow (*J. Infect. Dis.*, 33:248, 1923) isolated non-hæmolytic streptococci from the craters of chronic peptic ulcers, from adjacent gastric lymph glands, and from septic tonsils in patients suffering from ulcer. The inoculation of animals with these organisms led to the production of both gastric and duodenal ulcers in a significantly high proportion of cases. He claimed that these bacteria were specific and had an elective affinity for the mucous membrane of the stomach or duodenum, since when streptococci were used from other foci of infection procured from patients without ulceration a peptic ulcer resulted in only a very few instances.

Although his views are not universally accepted, his experiments have been repeated on a number of occasions with confirmatory findings. It would seem therefore that bacteria originating in a septic focus, *e.g.*, a diseased appendix, may pass into the blood stream and be excreted by the mucous membrane of the stomach or duodenum, producing necrosis of the mucous membrane, which subsequently becomes digested by the gastric juice, leading to the formation of an ulcer.

The natural tendency for acute ulcers is to heal quickly, but new ulcers will continue to develop if the primary cause of the infection

is not eradicated. The removal of all accessible septic loci is therefore of paramount importance, both with regard to the prevention of peptic ulceration and in its treatment, as is amply shown in the results following such measures. Local infection, such as gastritis or duodenitis, is held by many observers, including Konjetzny, Puhl, Bevan and Smithies, to be an important ætiological factor. The gastritis theory originated in the German clinics where on examination the majority of gastrectomy specimens showed ulcers associated with gastritis. This association was so significantly constant as to imply either that the ulcers produced the gastritis or that the gastritis produced the ulcers. Intelligent use of the modern flexible gastroscope would appear to support the latter view, although it is generally conceded that gastritis is not so common or of such importance in Britain or America as it is in Germany.

That non-bacterial toxins may account for ulceration is evidenced by the multiple acute erosions which may be seen at times in cases of uræmia and by the fact that chronic peptic ulcers can be produced in dogs by feeding them with cinchophen (Mann).

Imbalance in the Vegetative Nervous System. The frequent presence of duodenal ulcer in highly-strung, so-called dynamic individuals, and the recrudescence of symptoms especially during periods of stress or worry, have been mentioned by many writers including Hurst, Bevan, Hunt, Rivers, Smithies and Robinson. The possibility of an association between the mental state and changes in the gastric or duodenal mucosa is an interesting study. An imbalance in the vegetative nervous system has been considered by Rokitansky, Harvey Cushing (*Surg., Gynec. & Obst.*, 55:1, 1932) and von Bergmann to be an ætiological factor.

Lack of Essential Vitamins. This theory receives strong support from McCarrison and Somervell and Orr. It is now generally agreed that ulcers are liable to arise in those who through circumstances are habitually obliged to live on inadequate fare, which is deficient in vitamins, and particularly vitamins A and C.

Vascular Accidents and Deficiencies in Blood Supply. The old view of Virchow that peptic ulcer is primarily due to embolism of the small vessels of the mucous membrane is difficult to substantiate, since peptic ulceration is rarely, if ever, seen in cases in which there are multiple emboli in such organs as the kidney or spleen, unless

these emboli are associated with gross sepsis. Moreover, although thrombosis of the gastric blood vessels may be followed by ulceration it does not appear to occur with particular frequency in patients suffering from general arterial degeneration or peripheral thrombosis. We may therefore infer that embolism and thrombosis of the blood vessels of the stomach and duodenum are seldom primary factors in the production of ulceration except where there is a concomitant septic element.

It has been shown by Wilkie (*Lancet*, 2:1228, 1927) and Reeves (*Surg., Gynec. & Obst.*, 30:374, 1920) that the anterior wall of the duodenum and the lesser curvature of the stomach have a relatively precarious blood supply. W. J. Mayo (*Ann. Surg.*, 57:69, 1913) has demonstrated that if at operation the anterior wall of the duodenum is gently pulled downward and held in this position for a short time, a white anæmic area will appear here about $\frac{1}{2}$ -inch distal to the pylorus.

The Secondary or Acid Factor. The importance of hydrochloric acid in the perpetuation of peptic ulceration is well recognised. Peptic ulcer can only occur in those portions of the gastro-intestinal tract which are regularly bathed with acid. The presence of heterotopic gastric mucous membrane would account for the production of peptic ulcer in the œsophagus and in a Meckel's diverticulum (Matthews and Dragstedt; *Surg., Gynec. & Obst.*, 55:265, 1932), while almost the only circumstances in which a peptic ulcer can occur in the jejunum is where this portion of the gut is anastomosed to the stomach, as in the operation of gastro-jejunostomy which exposes the jejunum to the influence of gastric juice to which it is unaccustomed (fig. 22).

A peptic ulcer cannot develop in the absence of acid. Marked gastritis is always present when ulcer is associated with anacidity. Here the mucus prevents gastric secretion by plugging the mouths of the ducts or by rendering the acid secreted inert by neutralising it or by combining with it. After a course of gastric lavage the gastritis will subside and fresh samples of gastric juice will again show the presence of acid.

In diseases where there is anacidity, e.g., pernicious anæmia, peptic ulcer has never been known to occur. Acidity is not of itself the primary cause of peptic ulceration. The gastric juice has no elective

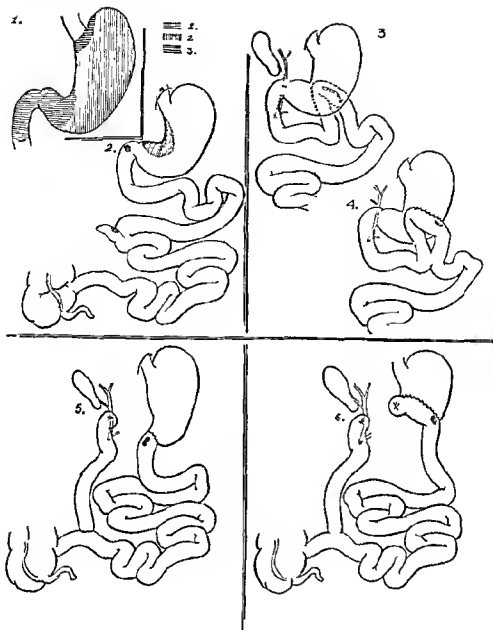


FIG. 22.—TUE ACID FACTOR.

(1) This figure shows the area occupied by: 1, the cardiac glands; 2, the principal glands; and 3, the pyloric glands.

(2) The common sites for peptic ulceration in man (shaded area).

(3) The commonest site for a jejunal ulcer to develop following posterior gastro-jejunostomy.

(4) The common site for the development of jejunal ulcer following anterior gastro-jejunostomy combined with entero-anastomosis.

(5) and (6) Mann and Williamson's experiments on animals (*Ann. Surg.*, 77, 409, 1923), showing that when the alkaline juices are deflected to the lower coils of the ileum a jejunal ulcer almost invariably forms just distal to the newly-fashioned gastro-enteric stoma.

affinity for any particular portion of the normal gastric or duodenal mucosa. Before an ulcer can develop there must be a devitalised or damaged area produced by some other agency which paves the way for the digestion of the necrotic tissue by the pepsin of the gastric juice which can only act in the presence of free hydrochloric acid.

The appreciation of the acid factor in the pathogenesis of ulcer is, as has already been stated, of the greatest importance in treatment, since both medical and surgical measures aim at neutralising, diminishing, controlling or abolishing its production. Alcohol and tobacco seem to play their part in ulcer causation, chiefly by augmenting the secretion of acid.

In discussing the part played by acid we must remember the other side, the mechanism for its neutralisation, and consider whether the cause we seek is an excess of acid or a failure in the protective mechanism. It is necessary to insist that ulcers are almost limited to sites where the secretion is alkaline and not acid, and that the majority of experimental ulcers have been produced, not by increasing the acid, but by decreasing or diverting the alkali.²

The Mechanism of Gastric Secretion. Ogilvie again writes on this subject as follows:

The gastric mucous membrane contains three types of glands—the cardiac, the fundus or principal glands, and the pyloric glands. In man the cardiac glands occupy a small strip only near the cardia, the principal glands line the whole fundus and body, while the pyloric system takes an area $2\frac{1}{2}$ to 3 inches wide proximal to the pylorus. (See Fig. 22.) The principal glands produce acid and pepsin. The pyloric glands which are probably identical in function with Brunner's glands in the duodenum, secrete an abundant mucinous fluid, of soapy appearance and highly alkaline reaction. Three additional substances, at any rate, can be identified in extracts of pyloric and duodenal mucous membrane—the anti-anæmic factor of gastric juice, (hæmopoietin or Castle's intrinsic factor) histaminase, which neutralises the action of the histamine, and a hormone—gastrin—that calls up secretion of hydrochloric acid and pepsin in the principal glands. The cardiac glands are probably similar in function to the pyloric, sentinels that guard the œsophagus from acid damage as the lower group guard the intestine.

The mechanism of gastric secretion has been investigated in the main with regard to the flow of pepsin and hydrochloric acid. Two factors have been demonstrated. First, the sight, smell, or even the thought of food produce an abundant flow of gastric juice; this, called by Pavlov the psychic flow, de-

² Ogilvie, *Lancet*, 2 295, 1938.

pend on nervous impulses and ceases if the vagi are cut. Secondly, peptone and various meat extracts, acting on the mucous membrane of the pyloric antrum, produce a hormone named gastrin by Edkins, its discoverer, which leads to a further flow of gastric juice. The psychic flow provides a digestive bath for the arriving meal, the chemically induced flow continues the process when appetite is sated.³

PATHOLOGY

Fully 70 per cent of chronic peptic ulcers are found in the duodenum. Of these 99 per cent occupy the first part, 85 per cent are within 1 to 1½ inches of the pyloric outlet, 10 per cent abut upon the pyloric ring, and slightly less than 1 per cent occur in the second part of the duodenum above the ampulla of Vater. Is the solitary chronic duodenal ulcer found more frequently on the anterior wall or the posterior wall of the bulb? On this point there appears to be no general agreement at the present moment. Hurst and Stewart (1929) state that most of these ulcers will be seen on the anterior wall and this is borne out by the figures of the Presbyterian Hospital series (1938) where about 70 per cent of the ulcers were found on the anterior wall, the remainder being distributed about equally on the posterior and superior surfaces, very few occurring on the greater or inferior curvature. Kohler (1935) disagrees with this, estimating that a greater number are found on the superior aspect (lesser curvature) while Karsner (1931) considers that the posterior wall is the commonest site. Eusterman and Balfour (1935) state that the frequency of lesions on the posterior wall can be proved by the fact that at post-mortem examination in 71 per cent of cases in which ulcers were found the actual ulceration was seen to be only on the posterior wall. If we exclude the acute perforations which occur on the anterior wall or near the superior surface of the duodenal bulb, at operation the majority (fully 65 per cent) of chronic duodenal ulcers are found to be located on the posterior wall, about 1 cm. or so from the pyloric ring, and it is these ulcers which so frequently become attached to or actually penetrate into the substance of the pancreas and which account for most of the technical difficulties associated with partial gastro-duodenal resection.

Multiple ulcers occur in 30 per cent of cases. These are usually

³ *Ibid.*

seen on the anterior and posterior walls, facing one another like contact ulcers, and produce a considerable amount of scarring and distortion of the bulb. Combined ulcers, *i.e.*, ulcers in both the stomach and duodenum in the same patient, were reported in 8 per cent of cases in Present's series. Eusterman and Balfour found 15 per cent of gastric ulcers to be associated with duodenal ulcers, and 6 per cent of duodenal ulcers to be associated with gastric ulcers. Wilkie (*Lancet*, 2:1228, 1927) discovered 51 combined ulcers in 362 peptic ulcer patients, an incidence of 15 per cent, Rivers (*Arch. Surg.*, 30:702, 1935) found a co-existence of 13 per cent, while Graves (*Ann. Surg.*, 1933), as a result of intensive research into the statistics of Central European Hospitals, notably in Germany, reported the finding of combined ulcers in over 30 per cent of the cases investigated by him (fig. 23).

Chronic duodenal ulcers are on the whole smaller than gastric ulcers, the average size being 1 cm., although in rare instances they may measure as much as 5 cms. across the crater. They vary considerably in shape and may be circular, crescentic, oval, triangular or pear-shaped. Irregularity in outline in the case of a duodenal ulcer is of little importance, whereas in a gastric ulcer such irregularity would suggest the possibility of cancerous transformation in the margin. The ulcer has a punched-out appearance, the margins are overhanging, receding or terraced, and the base is covered with muco-purulent debris. The depth of the ulcer will depend upon the degree of penetration which has occurred, and at the height of inflammatory activity the muscularis is always more or less completely breached.

The characteristics of chronic ulcer are:

1. Complete destruction of the muscularis in the centre of the ulcer.
2. Dense fibrosis in the base.
3. Adhesion of the muscularis mucosæ to the muscularis at the margin of the crater.
4. The presence of peri-arteritis and endarteritis in the surrounding vessels.

The mucous membrane around the ulcer will, in addition, show the usual proliferative and regenerative changes. As a result of the accompanying fibrosis the first portion of the duodenum becomes



FIG. 23.—COMBINED PEPTIC ULCERS.

Skiagram shows a huge gastric ulcer associated with a small duodenal ulcer which has produced pyloric obstruction (Graham Hodgson).

distorted and shortened. The normal distance from the pylorus to the papilla of Vater is 8 cms., but this may be reduced to 4 cms. or less by contracting fibrous tissue such as is found in long-standing cases of duodenal ulcer—a fact which is well-recognised by surgeons who undertake partial gastro-duodenal resection for this condition.

On *microscopical examination* the appearance of an ulcer will be found to vary according to whether it is in a state of activity or is healing. If in the active stage, there will be a considerable degree of œdema, infiltration of the base and margin with leucocytes, and evidence of an increased proliferation of fibroblasts. The margins of the ulcer will be seen curling over toward the base, the muscular coats will be entirely breached, while the granulation tissue lining the walls of the crater will show engorgement with blood. During the stage of healing, owing to the contraction which takes place in the scar tissue, the size of the ulcer will be diminished, there will be an up-turning of the breached muscle ends, the purulent exudate which covers the floor of the ulcer will be absorbed, the granulation tissue will assume a fresh, healthy and active appearance, and there will be a subsidence in the venous and lymphatic engorgement around the margins, leading to a flattening out of the mucous membrane, which creeps across the now rejuvenated ulcer bed.

Healing is always precarious, as the floor of the ulcer is covered in the first instance with a single layer of epithelium. When conditions are favourable, downgrowths of this layer of epithelium appear together with other changes, until an inferior mucous membrane, somewhat resembling the original but thinner and less convoluted, is reproduced. In view of the fixation of this new mucous membrane to its sclerotic base with its poor blood supply—the outcome of endarteritis—and its loss of flexibility, the frequency with which recrudescence of ulceration is seen to occur at the same site is hardly surprising.

It is very probable that many chronic ulcers which heal completely, break down again many times subsequently. The final result of the cicatrization of a chronic ulcer will depend upon its situation, size and chronicity. So far as duodenal ulcer is concerned, when a severe degree of contraction occurs pyloric stenosis results, and the commonest cause of occlusion of the outlet of the stomach is a cicatrising duodenal ulcer. Should a peptic ulcer situated in the lower end of

the œsophagus—œsophageal peptic ulcer—contract unduly, œsophageal obstruction will ensue, and in the case of a saddle-shaped ulcer on the lesser curvature, particularly in women, it is well known that hour-glass stomach frequently results from the shrinkage of the scar tissue.

At operation the majority of duodenal ulcers are readily recognised, only a very few of the more secretive ones located on the posterior wall proving difficult to identify.

In ulcer cases operation is advised for treatment and not for purposes of diagnosis. With modern methods of investigation, the pre-operative diagnosis of ulcer may be said to be correct in fully 96 per cent of cases. At operation therefore we expect to find the stigmata of a callous ulcer, *i.e.*, of one that has resisted all attempts at cure by non-operative measures.

If on exposing the stomach and duodenum no evidence of ulceration can be found, the position is at once perfectly clear: no operation directed to the cure of a supposed ulcer can be countenanced and we must search elsewhere in the abdomen for lesions which are capable of producing reflex dyspeptic symptoms, *e.g.*, chronic appendicitis, and deal with them accordingly. The difficult cases are those in which the patient gives a history of ulcer, where a long course of medical treatment has been undertaken without appreciable improvement, where numerous biochemical investigations support the diagnosis of ulcer, and where although a barium meal examination shows what appears to be an ulcer niche or a totally deformed cap, yet at operation no ulcer can be detected, in fact, the duodenum, both on inspection and palpation, appears to be normal.

When faced with such a problem the surgeon must incise the anterior wall of the pylorus and the bulb and inspect the posterior wall of the duodenum. If after a careful search no ulcer is found, the wound in the gut must be closed transversely as in the Heineke-Mikulicz or Horsley pyloroplasty. The surgeon can then with all honesty inform the clinician or radiologist that his enquiries at operation have been thorough and exacting and that although every test supported a diagnosis of ulcer, none has been found to be present.

Nevertheless, as I have previously stated, the presence of ulcer can in most instances be easily verified on exploration; the ulcerated area will be felt as a hard, fibrotic mass or a cartilaginous, button-like

tumour; the ulcer bed can often be palpated by the tip of the finger which invaginates the gut; the portion of the bowel just distal to the vein of Mayo will frequently be seen to be distorted, puckered, scarred, narrowed or pouched; the adjacent gastro-colic and gastro-hepatic omenta may be tethered to the pancreas by the penetrating lesion, while the duodenum may be dragged out of position and bound to the under-surface of the liver or to an adjacent structure such as the gall-bladder by filmy vascular bands or transparent web-like membrane. The duodenum may be deeply placed and obscured by a sheaf of adhesions, but good retraction and careful dissection will bring it into view, revealing its cicatrised face.

It should be remembered that posterior wall ulcers give rise to unmistakable changes on the anterior wall, such as thickening due to oedema, mottling or speckling of the serosa on gentle friction, or superficial scarring. When a healed ulcer is found on the anterior wall, the posterior wall also should be examined for the presence of an active ulcer, as contact ulcers are by no means infrequent. The crater of a posterior ulcer may be difficult to find, particularly if the anterior wall is sclerosed. At times scarring is very extensive in the region of the pylorus and it may be almost impossible to say on inspection whether the ulcer which has produced the scarring is pyloric or duodenal; but it can be definitely stated that ulcers which begin at or within 1 inch of the gastric aspect of the pylorus are exceedingly rare, as examination of specimens removed by partial gastro-duodenal resection for pyloric stenosis will readily prove, and that in nearly every case cicatricial stenosis of the pylorus is due to chronic duodenal ulcer, the scar tissue resulting from which has spread to the left, thus obscuring the exact site of origin of the ulcer.

When a duodenal ulcer is found at operation, the surgeon should bear in mind the possibility of associated organic lesions in the stomach, appendix or gall-bladder, or even in all three organs simultaneously. Combined gastric and duodenal ulcers are by no means uncommon, and according to Rivers they are found in 13 per cent of all cases, while Wilkie (*Brit. M. J.*, 1:771, 1933) has stressed the frequent combination of chronic cholecystitis, chronic appendicitis, and stenosing duodenal ulcer—the abdominal triad, and also the association, especially in women, of gall-stones with ulcer—the cholecysto-duodenal syndrome.

Many writers have discussed the possible relationship between appendiceal disease and peptic ulcer. For instance, Hartman and Rivers (*Arch. Int. Med.*, 44:314, 1929) reported chronic appendicitis to be present in 35.7 per cent of gastric and 44.4 per cent of duodenal ulcer patients, while Smithies' rate (*Am. J. Digest. Dis. and Nutrit.*, 1:697, 1934) was 36 per cent. Larimore (*Surg., Gynec. & Obst.*, 50: 59, 1930) noted that 18 per cent of his cases had had their appendices removed, while Somervell and Orr in their statistics from India found a concomitance of 73 per cent. Many surgeons recommend that on completion of an operation for peptic ulcer the appendix should be removed (usually through a small gridiron incision), whether this organ appears to be diseased or not.

The complications of duodenal ulcer—obstruction, perforation and hæmorrhage—are discussed in some detail in subsequent chapters.

DIAGNOSIS

The methods commonly employed for the diagnosis of gastric and duodenal disorders include the following:

1. History of the case.
2. Physical examination of the patient.
3. Radiological examination.
4. Laboratory investigations.

These include: (a) gastric analysis; (b) duodenal intubation and examination of the withdrawn duodenal juice; (c) tests for occult blood; (d) examination of the urine and tests for renal efficiency; (e) complete examination of the blood, including hæmoglobin estimation, white-cell count, differential white-cell count, red-cell count, colour index, non-protein nitrogen of the blood serum, the CO_2 combining power of the plasma, the blood chloride, the Wassermann reaction and Kahn test for syphilis, etc.

5. Gastroscopy. In order to obviate errors in diagnosis, it is good practice to subject all patients who are suspected of having gastric or duodenal lesions to a routine method of investigation such as has been outlined above. I attach the greatest importance to a painstaking history of the case and to a physical examination of the patient—clinical methods, and I consider that with our increasing knowledge of the symptomatology of gastro-intestinal diseases a correct diagnosis

can be arrived at in the majority of cases by these methods alone. Certainly in chronic duodenal ulcer the symptoms are so characteristic that in approximately 90 per cent of cases a confident and correct diagnosis can be formed on the history per se. But "seeing is believing," hence the services of the radiologist are required in every case, and the opinion of the gastroscopist is being sought for with increasing frequency.

No pre-operative diagnosis of chronic duodenal ulcer can be upheld unless it receives the approval of the radiologist, while at operation no diagnosis of duodenal ulcer can be supported unless the ulcer itself or the consequences of the ulcer can be unequivocally demonstrated.

SYMPTOMS

The majority of acute duodenal ulcers are unrecognised during life as they do not produce symptoms unless bleeding or perforation occurs. Chronic indigestion, nausea, abdominal discomfort, etc., may be associated with an acute ulcer, but in such cases the dyspeptic symptoms are secondary to lesions of the abdominal viscera and especially of the appendix and gall-bladder.

On *abdominal examination* nothing abnormal will be detected; muscular rigidity, tenderness, and distension are not present; in fact there are no physical signs of any importance, except perhaps those caused by an associated lesion, which might be held to account for the symptoms of indigestion. During the active phase of acute ulceration, tests for occult blood will be positive, but a barium meal examination will give negative results.

The cardinal symptoms of *chronic* duodenal ulcer are pain, vomiting and bleeding, by far the most outstanding being pain. The characteristic story obtained is one of intermittent attacks of epigastric pain extending over a period of months or years with free intervals varying from weeks to many months. This periodicity is very typical, at any rate in the early stages of the disease, but at a later date when obstruction supervenes the periodicity is lost and pain, although it may decrease in severity, becomes constant. In young patients indigestion which persists without interruption from its onset is unlikely to be due to peptic ulcer. Periodicity is generally more marked in duodenal than in gastric ulcer. Ulcer pain is of a very severe

nature and may be described as boring, aching, burning or lancinating. It is felt in the epigastrium, usually a little to the right of the middle line or perhaps further aside below the tip of the right costal cartilage, but it pierces fiercely through to the back when the ulcer erodes the pancreas. It usually comes on two to two and a half hours after meals, and is appeased by food (hunger pain), alkalis or vomiting. It is often relieved by rest in bed and by the benison of warmth. The bigger the meal, the greater the interval, but the worse the pain. After breakfast (a small meal) the interval is short, usually less than two hours, while after dinner (usually the largest meal of the day) it may be as long as three to five hours. Certain articles of diet, the intake of alcohol, or smoking will aggravate the pain, while worry and anxiety will intensify it. A characteristic feature is nocturnal pain, *i.e.*, pain which is bad enough to awake the patient out of his sleep late at night or in the early hours of the morning. Pain which is sufficiently acute to arouse a patient from sleep is likely to be organic in nature, whereas pain which increases in severity when the patient is in bed or prevents him from sleeping is suggestive rather of functional disorder.

Some patients know to the minute when an attack of pain is due and they will forestall it or at least dull its sharp edge by taking a glass of milk, a biscuit or some other article of diet.

Any change in the characteristics of the pain, such as increased persistence despite the use of alkaline medicines, denotes that new pathological processes are at work in the ulcer itself. Pain tends to become progressively more severe, and this crescendo characteristic is very marked during an acute attack. The attacks in some patients appear to have a seasonal occurrence and to be more common in the autumn and spring. Hunger pain, which was first described by Moynihan, occurs in many other conditions besides peptic ulcer, *e.g.*, chronic appendicitis, carcinoma of the stomach, chronic cholecystitis, hyperchlorhydria, from excessive smoking, and in certain nervous disorders. The cause of the pain which occurs in association with ulcer has not been definitely determined, but it is thought by some to be muscular in origin and to be produced either by tension or stretching of the muscular fibres and nerves in the vicinity of the ulcer or else by involvement of the parietal peritoneum. Most gastric symptoms are due to motor disturbances. When chronicity is estab-

lished, the attacks will increase in frequency and will last longer, the interval will shorten and the symptoms during the attacks will become more exhausting in character.

Vomiting is comparatively rare in uncomplicated duodenal ulcer and is much more frequently seen in association with gastric ulcer. This may be accounted for by the fact that in gastric ulcer spastic occlusion of the pylorus often takes place and nausea is a more prominent feature. When organic pyloric obstruction supervenes, vomiting will occur, but the symptoms will be those of obstruction of the outlet rather than those truly typical of ulcer. Water-brash is especially frequent in cases of chronic duodenal ulcer, as has been observed by Ryle who considers that the abundant production of this watery alkaline saliva is the natural reaction on the part of the organism to neutralise the excess of acid. In simple cases the appetite remains good and the patient will often gain weight and appear to be in sound health; but with the onset of stasis a loss of weight will ensue as a result of vomiting, a distaste for food, dietary restrictions, nocturnal pain and insomnia. Constipation is common and will be aggravated by the onset of pyloric obstruction. Other symptoms include a fullness or bloating of the epigastrium, belching or eructations, and nausea, which is, however, more common in gastric ulcer, cholecystitis and chronic appendicitis than in duodenal ulcer.

Bleeding is so common that it constitutes a symptom rather than a complication. Duodenal ulcer is the most frequent of all causes of gastro-intestinal hæmorrhage, and fully 90 per cent of such ulcers bleed at some time or another. Bleeding—melæna or hæmatemesis—of moderate or severe degree occurs in 30 per cent of cases, and peptic ulceration is the commonest single cause of profuse hæmatemesis. This subject is discussed at length on page 399.

In a small percentage of cases there appears to be no pain and no dyspeptic symptoms whatsoever, and the first evidence of a chronic ulcer may be an acute perforation or a torrential hæmorrhage.

Physical Signs. It is often taught that a physical examination of the abdomen will yield a negative result in the majority of ulcer patients, and consequently this method of investigation is likely to be conducted somewhat perfunctorily and carelessly. This is unfortunate since valuable signs are often present, and in addition its performance is necessary in order to exclude the possibility of con-

comitant disease in other organs. In my experience of ulcer cases I have, on deep pressure, usually found a point of tenderness in the epigastrium which may be exquisitely painful even during the period of quiescence. This sensitive area may be quite small, but its discovery is a most valuable piece of evidence. It should be sought for methodically with the tip of the index finger which presses deeply into the various parts of the epigastrium. During an acute attack of ulceration, superficial tenderness and muscular guarding can be elicited over the duodenum, but in the reposeful stage these may be entirely absent. The point of maximal tenderness is situated in the epigastrium, either at the outer border of the right rectus muscle or in the middle line nearer to the xiphisternum than to the umbilicus. It should be remembered in this connection that midline epigastric tenderness may be due to pressure on the aorta. There may also be a localised area of reflex tenderness at the back close to the right side of the spinal column at the level of the eleventh or twelfth rib. The painful area in the epigastrium is usually constant in position and does not move appreciably on respiration. It may be confused with gall-bladder tenderness, but here it is situated more laterally and is intensified by deep palpation during forced respiratory movements (Murphy's sign).

It should be remembered that the earliest sign of response in an ulcer to medical treatment is the disappearance of pain, which is followed successively by loss of tenderness and of muscular rigidity. On rare occasions a duodenal ulcer may form a palpable tumour. It is difficult, however, to feel such a tumour unless the patient is thin and has a flaccid abdominal wall. Its palpation, too, is more likely when the stomach is empty. It is often most difficult to determine on palpation whether the tumour is a fixed growth or a large inflammatory mass. When detected it will be found to be tender on pressure and will appear to be fixed to the pancreas, being immobile on respiration. A cancerous tumour is generally not accompanied by tenderness, and this point should be borne in mind in arriving at the clinical differential diagnosis.

When dilatation of the stomach results from a stenosing ulcer, there is distension of the epigastrium, visible peristalsis and splashing gastric sounds. By ordinary physical methods of examination it is impossible to discriminate between atonic dilatation of the stomach

and stasis produced by organic stenosis, and the diagnosis can only be clinched by radiology.

In the general examination of the patient particular attention should be paid to any evidence of carious teeth, gingivitis or enlarged tonsils. Pallor and anæmia may be marked, suggesting hæmorrhage, growth or some blood dyscrasia. A rectal examination should never be omitted.

Radiological examination is indispensable, and no method of enquiry in gastric disorder is complete and no diagnosis can be accepted as final until this has been undertaken. Not only can the presence of the ulcer be confirmed, but the severity of the complications which are present can be evaluated, as also the efficacy of the treatment which has been instituted (figs. 24, 25 and 26).



FIG. 24.—LEFT ANTERIOR OBLIQUE VIEW SHOWING THE CRATER OF A CHRONIC DUODENAL ULCER ON THE LEFT POSTERIOR WALL WITH LITTLE OTHER DEFORMITY (BULL).

The diagnosis of peptic ulcer by X-ray examination depends upon the demonstration of direct and indirect signs. The direct sign is the crater itself, the indirect signs being disturbances in the outline and function of the duodenum or stomach.

Using the modern technique of "pressure films," Akerlund, Berg, Golden, Cordiner, Calthrop and others have demonstrated craters in over 95 per cent of cases. Carman (1920) reported correct diag-

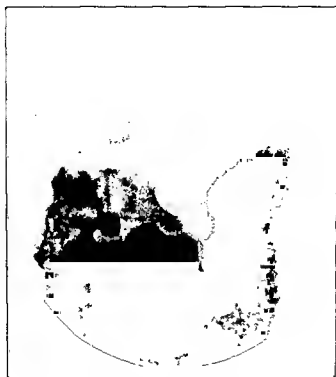


FIG. 25.—CHRONIC ULCER OF THE DUODENUM SHOWING DEFORMITY OF THE CAP (BULL).

noses in 96 per cent of peptic ulcer cases, Emory and Monroe (1929) in 93 per cent, while Miller, Pendergrass and Andrews (1933) showed only a 4 per cent error in 279 cases demonstrated at operation.

Diagnostic accuracy is inextricably bound up with technique, and provided this is efficient there is no portion of the alimentary tract which can be more thoroughly investigated than the duodenal cap. A useful account of the radiography of the duodenal cap is given by Cordiner and Calthrop in the *British Journal of Surgery* (23:92,

1936), to which the reader is referred for further information on this subject.

Analysis of Gastric Contents. The use of the Ewald one-hour meal has been in large measure superseded by the fractional test meal. The fractional specimens are analysed for total acidity, free hydrochloric acid, bile, blood, mucus and starch, and the results are



FIG. 26—CHRONIC ULCER OF THE DUODENUM WITH GROSS DEFORMITY OF THE CAP AND PSEUDO-DIVERTICULUM (BULL).

recorded on a special chart for easy reference. Gastric analysis is carried out as a routine on all peptic ulcer patients on admission to hospital, to serve not only as an aid to diagnosis but also as a guide to treatment. This analysis may also have an important bearing on prognosis, and may influence the choice of surgical procedures when these are indicated.

In interpreting the results of such analyses attention must be paid

to the curves of both free and total acid, to the emptying time of the stomach, to the presence or absence of abnormal constituents such as blood, and to the amount of mucus present. In *gastric ulcer* both free and total acid are often within normal limits and the curves resemble those of a healthy individual; occasionally however, hyperchlorhydria is found and blood is frequently detected in the specimens. In *duodenal ulcer*, on the other hand, characteristic curves may be obtained, these being of two main types: (1) The *climbing curve*, where the resting juice is strongly acid, and after a preliminary fall due to dilution there is a gradual rise in acidity during the whole meal. The stomach empties slowly and little or no regurgitation takes place from the duodenum, so that bile is absent from the specimen. It is this lack of regurgitation due to pylorospasm which accounts for the continued rise in acidity. (2) The *hurry curve*, associated with a rapidly emptying stomach. The resting juice is again highly acid. After a preliminary fall the curve again rises as acutely as before and may form a "plateau" or "mountain peak," then once more falls to its original level. The stomach empties in about an hour, as shown by the absence of starch. Both these curves are hypersecretory in type and are characteristic of duodenal ulceration.

When *organic pyloric obstruction* is present and is due to a cicatrizing duodenal ulcer, the fasting juice withdrawn may show a high volume and an excess of mucus, but food particles are often present. The acidity is generally high and there is, as a rule, an unpleasant smell or altered blood in the specimens. The large volume, the composition, and the high degree of acidity of the fasting juice all combine to make a diagnosis of benign obstruction almost certain. In long-standing cases, however, owing to the advent of gastritis or to atrophy of the gastric glands, free hydrochloric acid may be absent or be present in only small quantities. It may be well to state afresh that anacidity may exist in cases of duodenal ulcer unassociated with obstructive symptoms, and when this occurs medical treatment directed to the cure of the gastritis which is invariably present should be instituted without delay. It is common to find that after a course of well-applied and efficient medical therapy, the free acid returns to normal values.

The statistics relating to gastric analyses following *gastric opera-*

tions, and especially after gastrectomy for ulcer, are, on the whole, most misleading. I have confirmed on repeated fluoroscopic examinations that if a stomach tube is passed in a patient upon whom a partial gastrectomy or a gastro-jejunostomy has been performed, the tip of the tube has an uncanny knack of worming its way through the stomach and strma into the duodenum or into the efferent limb of the jejunum—the line of least resistance, so that when suction is applied intestinal instead of gastric contents are withdrawn and sent for investigation. In patients who have had a previous gastric operation, it is, in my opinion, therefore, imperative to check up the exact position of the tube by X-ray examination before withdrawing gastric contents for purposes of analysis.

Occult blood. Tests for occult blood should be routinely carried out on all patients suspected of ulceration. Preliminary dietary restrictions should be instituted, and other possible sources of bleeding, e.g., septic gums or hæmorrhoids, should be excluded. Over 60 per cent of peptic ulcers bleed in small amounts and at intermittent periods, while in a further 30 per cent the hæmorrhage may be described as moderate or severe in character. Hence an examination of the stools is important as an aid to diagnosis and to treatment. A negative result does not rule out the possibility of ulceration or of organic disease, but a positive result is of the greatest value since it negatives a diagnosis of nervous dyspepsia.

Other Tests. These include examination of the urine and tests for renal efficiency, in addition to searching investigation of all the constituents of the blood to detect any abnormalities which may be present. The inestimable value of these examinations and of the results they yield has been repeatedly stressed as playing an important part in the direction of the pre-operative management of the case, in gauging the vital capacity of the patient to withstand the contemplated operative procedures, and in suggesting the correct lines upon which a scientific post-operative regime of treatment should be conducted. Without these tests, much done for such patients would be by rule-of-thumb or, at best, based upon deplorable guess-work.

Gastrosocopy. The gastroscope in capable hands is a valuable instrument and is now proving indispensable in the diagnosis of gastric disorders. Harold Edwards, with his long and expert knowledge of the Wolf-Schindler flexible gastroscope, considers that gastrosocopy

can be carried out without risk, and that its performance causes but little discomfort to the patient. He writes:

'The gastroscope permits of direct inspection of the greater portion of the lining of the stomach, but experience is necessary in order to interpret the findings, and particularly to master the technique of orientation. Gastros-copy does not in any way replace or rival X-ray examination, which should always be performed before gastroscopy is contemplated.

Gastros-copy may be a useful adjunct to radiological examination in the diagnosis of gastric ulcer, especially in obscure cases, and may be of value to the clinician in checking the results of medical treatment.

It is of the greatest assistance in cases of suspected carcinoma when the clinical and radiological findings are equivocal. It is the best means at our disposal of making a diagnosis of chronic gastritis, and also of the nature of morbid conditions affecting the stoma in gastro-jejunoscopy. Finally, gastroscopy may be the means of saving the patient an operation.

The gastroscope has therefore a definite field of usefulness in the management of cases of gastric disorder, and with increasing experience of the operator, and perhaps when still further improvements are made in this most ingenious instrument, this field of usefulness will be more widely extended.⁴

To those who are particularly interested in this subject I would recommend Hennings' *Text-book on Gastros-copy* (1937) which has been so ably translated into English by Rodgers; Rodgers' lecture in the *Medical Society Transactions* (61:80, 1938), and also the comprehensive articles which have been written by Herman Taylor (*Brit. J. Surg.*, 469:July 24, 1937), Moersch and Snell (*Collect. Papers Mayo Clin.*, 29:3, 1937) and Schindler (*Surg., Gynec. & Obst.*, 67:443, 1938).

DIFFERENTIAL DIAGNOSIS

The differential diagnosis of duodenal ulcer is based upon a careful consideration of the history of the case, a thorough physical examination, a study of the blood and stools, and radiological investigations. Every patient suffering from chronic indigestion has a potential ulcer until it is proved otherwise, and in such cases we can only be dogmatic when our investigations have been exhausted and have followed the lines already suggested.

It is surprising the number of diseases, both functional and organic, which closely mimic chronic duodenal ulcer, e.g.:

⁴ Harold Edwards, *Lancet*, 2:1161, 1935.

1. Nervous gastric disorders: (a) functional; (b) migraine; (c) gastric crises of tabes.

2. Reflex dyspepsias: (a) appendix dyspepsia; (b) gall-bladder dyspepsia; (c) prostatic dyspepsia from prostatic enlargement; (d) pancreatic disease; (e) carcinoma of the colon and other intestinal conditions; (f) iliocæcal tuberculosis; (g) epigastric hernia; (h) post-operative adhesions; (i) visceroptosis.

3. Other organic and duodenal disorders: (a) gastric ulcers; (b) chronic gastritis and duodenitis; (c) cancer of the stomach; (d) innocent new growths of the stomach; (e) syphilis of the stomach; (f) tuberculous ulceration of the stomach; (g) gastric and duodenal diverticula; (h) duodenal ileus; (i) duodenal bands and adhesions.

TREATMENT OF CHRONIC DUODENAL ULCER

A vast amount has already been written upon this important subject, and there is yet no sign of a subsidence in the yearly flood of literature which continues to appear. The treatment of chronic duodenal ulcer has aroused universal interest and provoked sharp controversy and even acrimony both in medical journals and in debates before learned societies. It may, nevertheless, be truthfully stated that in this matter *medicine and surgery* are today united where yesterday they were separated, the measures advocated being in all particulars complementary and not antagonistic. Surgery may be said to begin where medicine ends, but medical measures are once again invoked during the critical post-operative phase. The surgeon has no quarrel with the physician over the aims or the claims to efficacy of medical treatment, provided it is undertaken in judiciously selected cases and is well and thoroughly applied. In such circumstances comparison between the relative merits of medical and surgical treatment as conducted in our hospitals today is impossible, since, except in the presence of complications which unquestionably demand surgical interference, operation is reserved for patients whose condition medical measures have failed to cure after a reasonable trial.

But, to be successful, medical treatment must be in every sense adequate, strict, systematic, prolonged, and supervised only by those versed in the accepted scientific methods advocated by Hurst, Ryle,

Einhorn, Sippy, Bennett, Eusterman, Alvarez, Lahey and other experts in this field.

The practitioner is well advised to embrace no method of medical treatment which lacks the approval of a well-known specialist who is universally recognised by the profession as being an expert in gastric disorders, as certain regimes which claim that peptic ulcers can be cured by injections of foreign proteins and of histamine-like bodies, by the oral administration of hormones, by mixed endocrine glands in tablet form, by the application of light of various colours or of heat to the epigastrium, or by certain articles of diet, have no scientific bases to recommend their adoption except perhaps their simplicity and plausibility.

When the patient has completed his course of strict medical treatment and is fit to be discharged, it is most important for the practitioner to stress that should there be a severe recurrence of symptoms during the so-called ambulatory stage he must at once report this and to warn him that this will in all probability entail confinement to bed once more for a period which will vary according to his response to treatment. An acute exacerbation of ulcer pain implies activity of the ulcerative process and is therefore a danger signal. To permit the patient to be up and about attending to his daily affairs or to allow him to be his own physician at this critical time is, in my opinion, to take unwarrantable risks in the presence of a disease which is notoriously treacherous. There is no doubt that when efficient medical treatment is instituted for cases in which it is indicated it will yield a high percentage of gratifying results; but with all successful medical therapies danger lies in their abuse, there being a strong tendency to persist with such measures indefinitely when it should be obvious that they cannot bring about a cure. Furthermore, medical treatment as conducted by many practitioners is often doomed to failure from its inception through its being too cursory, too casual, or not sufficiently prolonged to be productive of lasting benefits.

I am convinced that many deaths which occur as the result of the complications of ulcer, such as perforation or hæmorrhage, and which swell the number of medical deaths to even higher figures than those primarily attributable to surgical interference, are due in no small measure to the institution of half-hearted remedial measures

at a time when they should be effectively applied, to insufficient personal supervision of the case, to neglect of periodic radiological and biochemical investigations when the patient's progress is unsatisfactory, and to an absence of self-discipline or co-operation on the part of the patient himself.

Many physicians have never known such complications as perforation or hæmorrhage to occur in patients who are undergoing strict medical treatment, and this, to my mind, is one of the strongest pleas in favour of medical treatment under a carefully supervised regime. Hurst writes:

I can only give my experience and that of my Guy's colleague, Dr. Ryle: neither of us has ever seen a case of perforation in a patient whilst under treatment. As to hæmorrhage, I have never known it occur in a patient under strict medical treatment unless he came in for hæmorrhage, in which case, of course, recurrence is not infrequent during the first week.⁵

But unfortunately my experience has not been so happy and is certainly not in accord with that of Hurst. I have operated upon patients in whom perforation has occurred when they were undergoing strict treatment in medical wards; I have known perforation to occur when they were undergoing routine pre-operative treatment, during gastric lavage, and during a course of barium meal examinations, and I have even known perforation to occur on the morning planned for operation on a patient suffering from chronic duodenal ulcer. I have, furthermore, seen and operated upon not a few patients who have bled white under the best medical care in well-equipped hospitals; nor is my experience by any means unique, as a perusal of medical literature will show. Maes and McFetridge have reminded us that no more devastating commentary on the subject can be imagined than that recently published by Vale and Cameron, in which they express the opinion that the patient who suffers his perforation in hospital while undergoing the most efficient medical treatment and while surrounded by all the resources of medical science is more likely to lose his life than is the patient who is stricken in his home or in the street.

During the first few years after the War of 1914-1918, a large number of patients with chronic peptic ulcer were subjected to surgi-

⁵ Hurst, *Post Grad. Med. J.*, 10 221, 1934.

cal measures indiscriminately and incompetently, with such a high percentage of consequent failures that a strong reaction in favour of prolonged medical treatment resulted, intensive alkaline medication being extravagantly boomed, both in medical literature and in the press, as providing a sure means of cure for such cases. Thus it was not long before such complications as acute perforation and haemorrhage rose to alarming proportions throughout the country, as a study of the statistics of any large general hospital will readily confirm.

This subject has been discussed by Hinton in America (*Am. J. Surg.*, 20:102, 1933) and also by Pyrah in England. Pyrah writes as follows:

There has been an increase in the medical treatment of ulcer and a decrease in the number of cases of chronic ulcer operated upon. The average number of operations per annum before 1926 (in Leeds) was over 200; the average number for the last four years was 140. There has been an increase since 1926 in the number of perforated ulcers of the stomach and duodenum. Between 1919 and 1925 the number of perforations averaged 50 per year; for the last five years the number has been 105 per year, that is, they have more than doubled.

In assessing the results of medical treatment we must take into account the mortality of complications, such as perforated ulcers, which may arise in patients thought to have been cured medically but who subsequently perforated. I cannot give the figures concerning that, but the deduction from the parallelism of the facts I have quoted, the increase in the number treated medically and the decrease in the number operated upon, shows, I think, that the increase in the perforations must be laid at the door of medical treatment.

The mortality from perforated ulcer from 1926-1931 in Leeds in 699 cases was 18.7%; the operation mortality for chronic ulcers was 5% for duodenal, and somewhere higher for partial gastrectomy, i.e., for gastric ulcers. So the increased number of perforation deaths is over the total number of operation deaths for chronic ulcer cases treated surgically. And many of the cases which had perforated returned later with symptoms, as, frequently, it is impossible to carry out the ideal surgical treatment at the time of the perforation.*

It is important to distinguish between relief of symptoms and cure of the ulcer. There will frequently be prompt relief from symptoms and in both general and local conditions when the patient is subjected to strict medical measures in hospital and is under supervision; but it is in the later ambulatory stage, when so much depends upon the loyal co-operation and self-discipline of the patient himself, that

* Pyrah, *Post-Grad. Med. J.*, 10:217, 1934.

a relapse is often experienced. This is perhaps hardly to be wondered at since this stage of the treatment calls for strength of character, determination, strict adherence to specific diets, the regular taking of medicines, and a careful observance of the details connected with the necessary regime over a prolonged period of time. Hence many ulcer patients, rather than face such prolonged demands upon their self-restraint and endurance, prefer to undergo surgical treatment without further delay, hoping thereby to secure a more speedy and effectual cure of their symptoms. These are unsatisfactory subjects for surgery, as they often fail to follow the necessary post-operative regime of management, their lack of co-operation accounting for many of the disappointing results which follow operative measures. Surgery as a quick method of cure should never be lightly advised or precipitately undertaken.

Gastric surgery today is embarked upon only, as Wilkie puts it, after careful deliberation and with due discrimination. In many instances operation opportunely performed will renew the patient's lease of life; on the other hand, a badly designed operation or operation in an unsuitable case may produce an increased and lasting state of ill-health and invalidism.

The main principles underlying the treatment of chronic peptic ulcer, whether by medical or surgical measures, will include: (1) The elimination of sepsis; (2) an avoidance of trauma; (3) the combating of acidity; (4) the correction of stasis, and (5) removal of the ulcer.

Where surgery is undertaken, medical measures form an essential part of the treatment, both before and after operation. In the surgical treatment of chronic duodenal ulcer, a high percentage of cures will result if the following points are observed: (1) Wise discrimination in the cases selected for operation; (2) care in the pre-operative treatment so as to render the patient as fit as possible for operation; (3) the selection of the correct type of operation required for the individual case; (4) the operation so designed that the patient may be able to tolerate and survive it; (5) the operation should not only aim at alleviation of symptoms, but it should afford freedom from the likelihood of recurrence of complications both early and late; (6) perfect mechanics and faultless, unhurried technique in the conduct of the operation; (7) prolonged post-operative supervision.

The final decision as to whether medical treatment or operation

should be advised should never be based on any rule-of-thumb method. A careful review of all the available evidence, both local and general, must be made in each case. So difficult may the making of this decision sometimes prove that the closest co-operation between physician, surgeon, radiologist and pathologist may be required, and in no instance is there greater need for the advantages afforded by team work.

Some Factors which Influence the Choice of Treatment.—Age. The younger the patient and the shorter the history, the more likely are medical measures to be successful. In the absence of complications operation should not be advised for young patients, *e.g.*, for those under 30 years of age, as in most instances the ulcer is of recent date, obstruction and anchorage are rare, and co-operation in the matter of post-operative caution is less easily ensured. A high incidence of jejunal ulcer and of other unsatisfactory results following the operation of gastro-jejunostomy is recorded in patients under 30. In young patients suffering from chronic peptic ulcer there are, as a rule, only two complications which call for surgical interference: perforation and recurrent hæmorrhage.

Perforation in such patients should be treated by simple suture, while the only satisfactory treatment for those very difficult but fortunately comparatively rare cases of recurrent hæmorrhage (in which there is always an extreme degree of hyperchlorhydria) is a gastro-duodenal resection sufficiently extensive to ensure the maximum reduction of the acid values of the gastric juice. The best results in gastric surgery for chronic duodenal ulcer are obtained in middle-aged patients, *i.e.*, those between 40 and 55 years of age, and such operations are, in fact, most frequently performed between this fifteen-year period.

Medical treatment for elderly patients is generally much less effective than for those who are younger, and this is no doubt in part due to the impaired circulation and diminished recuperative powers in the former (Conybeare). On the other hand, operative measures involve greater risks when undertaken in those of more advanced age. Nevertheless, in spite of this, operation, where unquestionably indicated, should be undertaken, the procedure being rendered as conservative as possible in the circumstances. The results of conservative operations, such as gastro-jejunostomy, in patients over sixty

years of age are eminently successful, as has been shown by Balfour (*Ann. Surg.*, 102:581, 1935), who obtained 94 per cent of cures, only 3.1 per cent of the remainder of the cases subsequently developed jejunal ulceration, and such has been the experience of many surgeons.

Sex. Sex does not necessarily influence the choice of treatment, although it should be noted that the mortality following gastric operation is lower in women than it is in men, and the late results are also uniformly better in women than in men. This, at least, has been my experience. Again, stomal ulceration is much more rare in females than in males after any type of short-circuit operation. Women patients, on the other hand, show a greater tendency to develop anæmia following a wide gastric resection, a point which has received emphasis from Gordon-Taylor, Morley and others.

Type of Patient, Occupation and Economic Status. The following types are all poor candidates for surgery: the neurotic, the alcoholic, the obese, the introspective, and the visceroptotic, as are also that group so capably classified by Goldthwaite as lean, nervous, anxious-minded young persons who live in a state of perpetual excitement. There is a high incidence of duodenal ulcer associated with hypersecretion, hypermotility and hyperchlorhydria in the professional classes, such as doctors, barristers, accountants and the like, whose mental activities are always at key pitch and who have to shoulder grave responsibilities. They are, on the whole, unsatisfactory for either medical or surgical treatment as their work and their habits and mode of life hinder them from paying the necessary attention to the details which are inseparable from the successful management of ulcer cases.

In the absence of complications, the ephemeral benefits of operation should be steadfastly denied them. They often show remarkable improvement during a holiday in the sunshine or by a complete change of climate, and at times a cure may be achieved by change of employment or at least by a reduction in the usual amount of their daily work; in fact, by going at a slower pace and by seizing every opportunity for relaxation and freedom from mental strain in the pursuit of interesting hobbies. On the other hand, the normal and phlegmatic types of patient—farmers, the well-to-do, and those in certain types of sedentary occupation, show a good result from treat-

ment whether medical or surgical. In the care of ulcer cases success so often depends not so much upon the type of treatment which is instituted as upon the individuals themselves who are being treated. Cigarette smoking, continued indulgence in alcohol and overeating are deterrents to the success of treatment. Nicotine by itself does not produce ulceration, but it does stimulate an excessive flow of gastric juice rich in hydrochloric acid and is thus capable of perpetuating ulceration. Therefore, to operate upon a patient with a duodenal ulcer and to allow him to smoke again without restraint would strongly predispose him to a re-activity of ulceration or even to the development of stomal ulcer.

The economic status of the patient is an important factor to be considered when deciding upon the best lines that treatment should take. In certain primitive peoples surgery is the lesser of two evils, and the same applies to ignorant or indigent patients who lack the will or the intelligence to follow out directions to the letter.

General Condition. Medical treatment should be adhered to for patients who suffer from chronic ill-health due to associated diseases such as phthisis, nephritis, serious cardiac lesions, and so forth, and operation should be undertaken only in the presence of urgent complications. Operation, too, is contra-indicated during pregnancy and the puerperium except when acute perforation takes place.

Length of Ulcer History. The shorter the duration of the disease, the better are the prospects of permanent healing by medical measures. This point at least is undisputed. Patients therefore giving a short history of duodenal ulcer are not good candidates for surgery, and I would have no faith in a surgeon who would advise surgical interference in such cases. Patients giving a long history, for example, of over ten years, during which time they have had many courses of medical treatment due to a persistent recurrence of symptoms, are best operated upon if no specific contra-indications are shown to exist.

So far as surgery for peptic ulcer is concerned, it is just as important for the surgeon to know *when* to operate as *how* to operate.

Statistics of permanent cure of duodenal ulcers by medical treatment do not give a higher valuation than 60 per cent. Conybeare (*Lancet*, 2:1017, 1935) estimated the percentage as not above 50.

• In evaluating the claims of a candidate for operation it is most important to enquire whether previous medical treatment has been

carried out with due care, and has been given a fair trial, as the longer the period of observation after medical treatment the greater becomes the proportion of relapses and the smaller the proportion of complete cures. It is only when efficient methods have repeatedly failed owing to some complication such as adhesions to adjacent structures, duodenal ileus, pyloric stenosis, or the presence of an additional lesion, *e.g.*, appendicitis, cholecystitis, etc., that surgical treatment should be considered. About 25 per cent of all patients suffering from chronic duodenal ulcer are eventually operated upon.

The Site and Pathological Characteristics of the Ulcer. In the past the radiologist had to base his diagnosis of duodenal ulcer chiefly upon indirect signs which were, on the whole, unsatisfactory. Deformity of the bulb may be caused by a variety of conditions, including active ulcer, duodenitis, reflex spasm, adhesions, or by scar tissue which follows healing; but now employing the newer methods of Berg—the aimed exposure with dosed compression—he is able to examine any suspicious portion of the duodenum, as it were, with a magnifying lens.

But X-rays will frequently not reveal the treacherous ulcer in the second portion of the duodenum for which surgical measures are so often necessary. Roscoe Graham (*Surg., Gynec. & Obst.*, 66:269, 1938) made a special study of these ulcers which occupied the descending limb of the duodenum just proximal to the ampulla of Vater and found that they did not give rise to any typical symptoms that would enable him to arrive at a correct diagnosis of duodenal ulcer. In about half of his cases skiagrams showed no gross abnormalities and operation had to be undertaken for repeated hæmorrhages or intractable abdominal pain and backache unrelieved by alkaline medication. He has termed such an ulcer “duodenal ulcer occulta.”

Ulcers on the anterior wall produce severe symptoms, but heal or perforate. They may be induced to heal by medical measures more readily than the posterior types, and on healing only infrequently cause scar stenosis. It is here that Berg's methods are so helpful in prognosis. Posterior ulcers, on the other hand, tend to become adherent to or erode the pancreas and it is during this process of penetration that the walls of the superior pancreatico-duodenal or even gastro-duodenal artery may be invaded, producing massive hæmorrhage.

It may be briefly stated here that if the patient has already been examined by means of X-rays and a chronic duodenal ulcer is known to be present, and if there has been a previous hæmorrhage and the existing one does not cease after blood transfusion, then operation, which will often amount to a direct attack upon the source of the bleeding, should be carried out.

Anchorage denotes chronicity. When a posterior ulcer has breached all the coats of the gut and its base lies deeply embedded in the substance of the pancreas—anchorage—it is unlikely that medical measures will prove availing and surgery will often be required to arrest or to forestall bleeding, to prevent the onset of acute ascending cholangitis due to perforation of the common bile duct by the ulcer—a rare but grave complication, to overcome stasis, or to rid the patient of an incorrigible and crippling pain which is totally incapacitating him.

Posterior ulcers on healing or during the height of a virulent activity often produce pyloric obstruction, and it is of the utmost importance for the clinician to distinguish between obstruction due to scar and obstruction due to a combination of spasm and œdema. Obstruction due to scar is a longstanding affair—organic obstruction, and the dilated, baggy, atonic stomach becomes a receptacle for decomposing, fermenting food and inert gastric juice which is voided in enormous quantities toward the close of the day. In such cases the gastric glands become atrophic and secrete little or no hydrochloric acid. On the other hand, obstruction due to œdema is of more sudden onset and is accompanied by severe pain and copious vomiting. On treatment by means of Wangensteen's method—intravenous salines with glucose to maintain fluid balance and food requirements—the obstruction is slowly overcome and subsequent gastric analysis shows an abundance of gastric juice with a superfluity of free acid.

Short-circuiting operations when performed for the two conditions I have just described will show markedly contrasting results. In scar stenosis, gastro-jejunostomy will be outstandingly successful, while in obstruction due to œdema this operation will be followed by a high percentage of dismal failures. The only indication for operation in the latter condition is recurrent attacks of obstruction which are difficult to control under medical management in patients who are losing heart. Here the correct procedure when it is capable of

being carried out with safety is partial gastrectomy and not gastro-jejunostomy.

Gastric Acidity. Most of the problems in ulcer management hinge upon the quantity and quality of the hydrochloric acid in the stomach, and it is agreed that operations performed for chronic duodenal ulcer show a far higher percentage of good results in patients with low acidity than in those in whom the acidity is high.

The estimation of the biochemical disturbances found in association with ulcer by laboratory methods is of great importance, not only in determining the correct measures that should be applied in the pre-operative management of the case but also in selecting the proper operative procedure, as I have previously attempted to show.

INDICATIONS FOR OPERATION

1. Acute perforation.
2. Recurrent hæmorrhage.
3. Organic (scar) stenosis.
4. Repeated failure of adequate medical treatment.
5. Chronic penetrating duodenal ulcer associated with chronic gastric ulcer.
6. Chronic duodenal ulcer associated with chronic duodenal ileus
7. Chronic duodenal ulcer associated with gall-stones or chronic appendicitis, or both.
8. Recurrence of ulceration following inadequate operation, *e.g.*, pyloroplasty.
9. Recurrence of severe symptoms following the operation of simple closure of a perforated duodenal ulcer.
10. Expedient circumstances and economic reasons in certain cases.
11. Duodenal ulcer occulta, *i.e.*, ulcer situated in the second portion of the duodenum just above the ampulla of Vater.

OPERATIVE PROCEDURES

1. Simple excision.
2. Operations around the pylorus:
 - (a) Pyloroplasty:

Horsley
Judd

- (b) Gastro-duodenostomy:
 - Finney
 - Jaboulay
- 3. Gastro-jejunostomy:
 - (a) Anterior
 - (b) Posterior
- 4. Partial gastrectomy:
 - (a) Billroth I types:
 - Von Haberer
 - Von Haberer-Finney
 - Shoemaker
 - Finochietto
 - Horsley
 - Mayo
 - (b) Billroth II types:
 - Anterior
 - Polya
 - Moynihan
 - Balfour
 - Pauchet
 - Posterior
 - Polya
 - Hoffmeister-Finsterer
 - Finsterer with pyloric exclusion
 - Bancroft's modification of Finsterer's operation with excision of the mucous membrane of the antrum
- 5. Miscellaneous operations:
 - (a) Partial fundusectomy—Connell;
 - (b) Gastric exclusion—Devine;
 - (c) Gastric devascularisation—Hey;
 - (d) Adrenal denervation—Crile.

For Chronic Duodenal Ulcer. The operations for chronic duodenal ulcer are legion, as a glance at the above list will show, some being merely interesting exercises in physiology. There is no one universally accepted and practised operation; standardisation has not yet been achieved. The success of any particular gastric operation de-

pende to a large extent upon the dexterity, the experience and the facilities of the surgeon by whom it is practised. One surgeon may perfect one particular method, while another masters another. Hence it is impossible to state that any one operation performed for a certain type of lesion will inevitably be followed by a given percentage of deaths or cures.

The judicious choice of operation will not only give a lower death-rate but a higher percentage of ultimate cures. But, as Walton (*Prognosis*, 1:105, 1935) has emphasised, in some cases unsatisfactory end-results compel the rejection of a relatively safe operation in favour of one associated with a higher risk.

From the end-results he has obtained from the various operations he has performed, the surgeon is in a position to give his patient a fair idea of the degree of success to be expected from one or another of the methods he may advocate. According to Graham, the patient who accepts operation demands: (1) Speedy recovery from the operation; (2) immediate relief from all symptoms; (3) security against recurrence of the disability; and (4) restored economic efficiency.

Although brilliant results have been achieved and with an increasing knowledge of the surgical requirements of individual cases the number of failures is decreasing rapidly each year, there is as yet much to be learned about this very difficult problem, more perhaps with regard to the correct choice of operation than as to the minutiae of technical details.

For our present purpose the operations for duodenal ulcer may be grouped as follows:

1. Simple excision of the ulcer.
2. Operations around the pylorus, *e.g.*, pyloroplasty, gastro-duodenostomy.
3. Gastro-jejunostomy.
4. Partial gastrectomy.
5. Miscellaneous operations.

I shall now attempt to assess the relative merits of these operations and to describe how they are performed.

Simple Excision of Ulcer. This consists of excising an ulcer on the anterior wall of the first part of the duodenum and suturing the defect thus produced at right angles to the longitudinal axis of the duo-

denum so that no narrowing results. It is the simplest, safest and rarest operation for ulcer, but is probably the most useless. It removes the ulcer, but does little else. It does not, for instance, counteract the cause of the ulceration, it deforms and traumatises the duodenum, it interferes with peristalsis, while there is often subsequent recurrence of ulceration. It may, nevertheless, be deemed advisable when, following cholecystectomy for gall-stones, a small ulcer is found on the anterior wall of the duodenum, fully 2 cms. away from the pyloric ring. It can be performed in a few minutes without adding to the risks of the primary major operation, while the prospects of cure in such instances would appear to be good.

Pyloroplasty. This operation aims at overcoming gastric stasis by division or partial excision of the pyloric sphincter, excision of an anterior wall ulcer, and counteracting acidity by regurgitation of alkaline juices through the patent newly-fashioned gastric outlet. Horsley (*J. Am. M. Ass.*, 73:575, 1919) considers that his operation is "physiologic" because it has the advantage of removing an ulcer in the first part of the duodenum and at the same time restoring function of the stomach to normal without any undue mutilation. He himself maintains that the operation has a limited field of usefulness and should be reserved for ulcers which although proving recalcitrant to medical treatment, at operation are found to be small and circumscribed and situated anteriorly close to the sphincter muscle, there being no surrounding infiltration or adhesions. He states that extensive adhesions, sub-acute inflammation around the ulcer, deformity of the bulb due to contracting scar tissue, the presence of a penetrating posterior wall ulcer, and an attendant duodenitis are all definite contra-indications to this type of pyloroplasty.

As surgery for ulcer is indicated only in the presence of complications and for callous lesions of long standing, it is obvious that the type of ulcer—small, on the anterior wall, producing no obstructive symptoms—for which Horsley's pyloroplasty would seem to be indicated, is very rarely encountered nowadays at operation. Some surgeons would, however, recommend this operation when, following an obligatory cholecystectomy or appendicectomy, a small uncomplicated ulcer is found on the exposed wall of the bulb near the pylorus, and when undertaken in such cases the late results appear to be tolerably good.

Horsley's Pyloroplasty. Horsley (1933), in his monograph, *Surgery of the Stomach and Duodenum*, lays special emphasis on the following essential points of this operation: Free mobilisation is unnecessary although adhesions, when present, should be divided; the duodenal incision must not be more than 1 inch (2.5 cms.) long, while the gastric incision is usually about twice that length to ensure complete division of the muscular fibres encircling the pyloric canal; conversion of a longitudinal into a vertical incision, rendering the pylorus widely gaping; sutures on the gastric side to penetrate the seromuscular coats but not the susceptible and friable mucosa; and sutures are made on the duodenal side to pick up all the coats of the gut.

The incision is made through the anterior wall of the stomach, exactly midway between the greater and lesser curvatures and at a corresponding point in the duodenum. Allis forceps are placed at the extremities of the proposed incision and help to draw the pylorus and duodenum well up into the wound. The incision in the first instance is made only through the seromuscular coats of the stomach and duodenum, down to the bulging mucosa. All bleeding points are caught with mosquito forceps and tied; the mucosa is incised, and the gastric contents are aspirated, after which the thickened ring of the pylorus is severed and the ulcer on the anterior wall of the duodenum is excised together with an ample surrounding rim of healthy tissue (fig. 27[1]). If a penetrating ulcer of the posterior wall is found, the operation should be abandoned and partial gastro-duodenal resection or gastro-jejunostomy substituted. The longitudinal incision is then made vertical by drawing together the two extremities with a suture which on the gastric side picks up only the seromuscular coats (care being taken to avoid the mucosa) while on the duodenal side all the coats are penetrated. This stay suture also acts as an efficient retractor while the wound is being sutured (fig. 27[3]). The longitudinal wound is now closed with two layers of continuous sutures, special pains being taken, as I have previously emphasised, to avoid traumatising the gastric mucosa or including it in a stitch.

The first suture starts at the interior (greater curvature) end of the wound, and is a simple through-and-through stitch which as it is inserted approximates the seromuscular coats on the gastric side and all the coats on the duodenal side (fig. 28[4]).

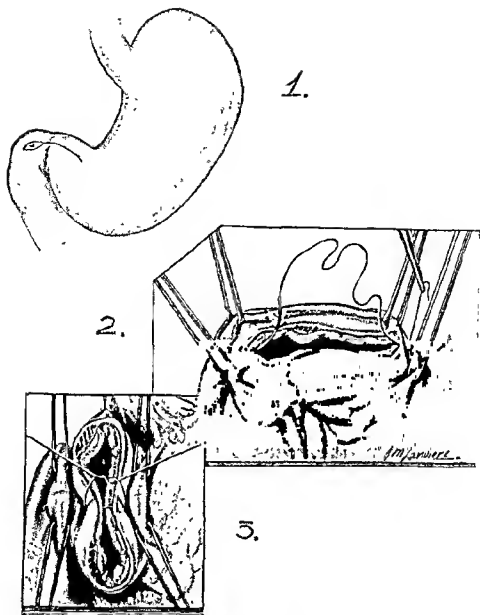


FIG. 27.—HORSLEY'S PYLOROPLASTY.

(1) Position of the incision in the pylorus and duodenum. A small anterior-wall duodenal ulcer is encircled by the incision as this ulcer is to be excised.

(2) The tractor suture is being inserted. Note that it includes the whole wall of the duodenum but only the muscular and peritoneal coats of the stomach.

(3) The tractor suture is being tied.

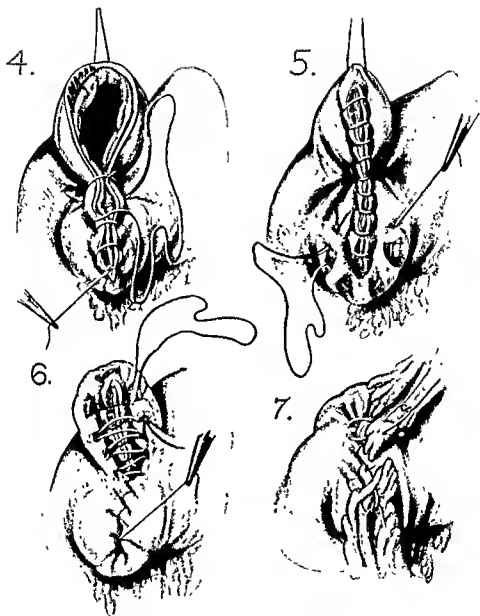


FIG. 28.—HORSLEY'S PYLOROPLASTY.

(4) The first row of sutures is being introduced. Note especially that the gastric mucous membrane is not pierced by the needle or picked up by any of the sutures.

(5) The first row of sutures has been completed and the second row is begun at the lower end of the wound as a purse-string suture.

(6) The second row of sutures is being terminated as a purse-string suture at the upper end of the wound.

(7) A couple of interrupted sutures bring over peritoneal-covered fat to protect the suture line.

When the divided end of the pyloric sphincter is reached, it penetrates the entire thickness of the duodenal wall, but again only the peritoneal and muscular coats of the stomach. The second and outer row of sutures is of the Cushing type which invaginates the stumps of the pylorus and the first layer of stitches.

At the completion of the operation the suture line is reinforced with a portion of adjacent gastrohepatic omentum above and gastrocolic omentum below (fig. 28[7]). In operations about the gastric outlet it is considered important to make every effort to prevent the subsequent onset of adhesions, as, if these occur they will eventually drag the newly-fashioned pylorus to the under-surface of the liver and thus interfere with the vital functions of the stomach, leading to a train of teasing dyspeptic symptoms.

Judd's Pyloroplasty. Judd (*Journal-Lancet*, 42:381, 1922) stated that many of the symptoms of duodenal ulcer are due to spasm and œdema of the pyloric sphincter, that the physiological reactions in the stomach and duodenum are altered, and that the concentration of hydrochloric acid is lowered after his operation is performed. The protagonists of Judd's operation consider that this pyloroplasty is particularly indicated if the patient is young (30 years of age or under) and of nervous temperament, the ulcer small, scarring slight, and the pyloric region easily accessible and free from adhesions. The chief contra-indications to the performance of this operation are anchorage of the duodenum to such an extent that it cannot be satisfactorily mobilised without undue risk in obtaining an approach to the ulcer; marked narrowing of the duodenum due to scar formation; pouching from the production of false diverticula; the presence of a large eroding posterior ulcer; and considerable dense fixation due to peri-duodenal adhesions.

It is claimed that this local operation is a simple undertaking in cases in which it is indicated; that it can be executed by a skilled surgeon with the lowest mortality (0.5 per cent) of any surgical procedure on the stomach or duodenum; that good results follow in fully 85 per cent of cases; and that protection is afforded against perforation, hæmorrhage and obstruction. Furthermore, Rankin and Grimes (*South. Surg.*, 6:164, 1937) state that it is not followed by the complications which are so frequently associated with gastro-jejunostomy, particularly those of pulmonary origin; indeed, it is most unusual

for a patient to develop bronchitis or pneumonia following this plastic operation.

It is said that in the few failures which follow this type of pyloroplasty (and secondary ulceration occurs in about 3 per cent of the cases), the operation in no way interferes with the subsequent performance of other relief procedures. The main complication, which is generally conceded to be rare, following this operation is leakage from the suture line in the post-operative period. Retention of gastric contents, however, frequently occurs and may be distressing, necessitating aspiration to prevent distension and vomiting. This delay in emptying of the stomach may persist for some weeks, but the late results are stated to be good. Nevertheless, this operation is very seldom practised in Great Britain since, in spite of the above mentioned claims, the end-results are far from gratifying and leave much to be desired.

TECHNIQUE OF JUDD'S PYLOROPLASTY. The operation consists of mobilisation of the duodenum, and wide removal of the anterior two-thirds of the pyloric sphincter, an adjacent portion of the antrum, and also the anterior wall of the bulb including the ulcer. The union of the stomach and duodenum posteriorly is not incised. When this incision is completed, the openings at the distal end of the stomach and at the upper end of the duodenum appear like the openings of a gastro-jejunostomy after the posterior layer of sutures has been introduced (fig. 29[2]). If a small shallow ulcer is found on the posterior wall this may be cauterised and the mucous membrane freed and sewn across, or the excision may be extended to include the lesion when this is situated on the inferior or superior border of the gut. The gaping oval or circular aperture which results from this excision is closed in the transverse axis with two layers of continuous sutures, and the completed suture line is further reinforced with layers of interrupted silk stitches and portions of adjacent omenta (fig. 29[3]).

The operation must be abandoned if a large fixed penetrating posterior wall ulcer is also found, or if all the scarred tissue on the anterior wall of the gut cannot be satisfactorily removed, for unless the parts concerned in the anastomosis are perfectly healthy, stricture forms at the line of suture and recurrence of ulceration is likely to follow.

Gastro-Duodenostomy. There are many ways of performing this operation, but only two well-known methods—that of Finney and that of Jaboulay—need concern us.

Finney's operation (*Surg., Gynec. & Obst.*, 43:508, 1926) has never been widely practised in European countries, although from what

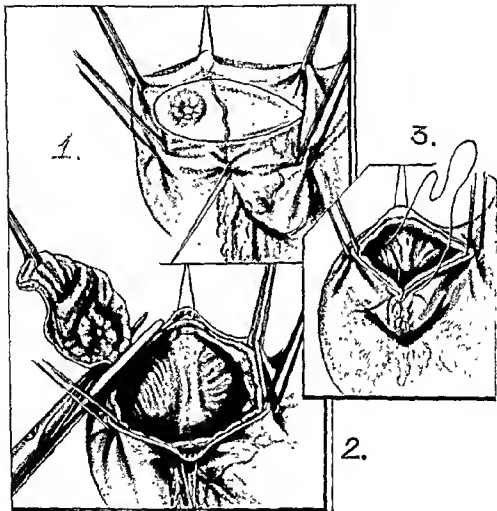


FIG. 29.—JUDD'S PYLOROPLASTY.

I am told it is frequently employed in America. I have rarely seen the operation performed, and this is probably due to the fact that most British surgeons prefer gastro-jejunostomy to any form of pyloroplasty or gastro-duodenostomy when a short-circuiting operation is indicated and that most of those who favour gastro-duodenos-

tomy usually choose the method of Jaboulay (which has been popularised by Wilkie) on account of its greater simplicity. The advantages of this type of pyloroplasty are said to be: (1) That it can be carried out with a low death-rate—1 to 2 per cent, and is simple to perform; (2) that the incidence of stomal ulceration is lower than that which follows gastro-jejunostomy; (3) that it permits of excision of an anteriorly placed ulcer and canterisation of a posterior wall ulcer; (4) that provided the ostium fashioned is large enough, there is practically no chance of complications of a mechanical nature, the danger of kinking being eliminated by the fixed position of the remaining undisturbed portion of the duodenum; (5) that there can be no damming up of gastric contents into a blind efferent loop because only the efferent limb of bowel is involved; (6) that it is more efficient than the limited pyloroplasties of Horsley and Judd in that stasis is more completely overcome owing to the large stoma that is made, that the free regurgitation of alkaline juices into the stomach neutralises acidity more readily, and that the final results are, on the whole, more uniformly pleasing.

Finney's operation is only possible where surrounding adhesions are absent or slight, where mobilisation of the pylorus and the first two parts of the duodenum presents no difficulty, and where the occlusion produced by an ulcer is only partial. It is contra-indicated where extensive inflammatory adhesions exist, where a large penetrating posterior ulcer is associated with a considerable degree of infiltration, œdema and fixation of the bowel, where the small omentum is thickened and the lumen of the duodenum is almost completely occluded, or where for any reason mobilisation is difficult or, when accomplished, will not permit of easy approximation of the duodenum to the stomach. I am astounded to find in the literature that surgeons recommend the performance of this operation for large, fixed, inaccessible posterior wall ulcers, as it is against the advice of Finney himself, who writes as follows:

If the pylorus and first portion of the duodenum are so bound down with scar tissue of a chronic ulcer, or too densely attached to under surface of liver and common duct to be properly freed, or if the seat of an ulcer, perforating into and intimately involving the head of the pancreas behind, interferes with proper mobilization for the performing of a pyloroplasty or prohibits a resection; then quite frequently one can still mobilize the second and third por-

tions to allow of a subpyloric Jaboulay type of gastro-duodenostomy, which has all the advantages referred to above. Incidentally, this is an operation which in our opinion is far too seldom used, which is simple to perform, and which accomplishes everything that a gastro-jejunostomy does without many of the latter's objectionable features.⁷

TECHNIQUE OF FINNEY'S OPERATION. There are two essential steps of the operation: (1) Thorough mobilisation of the pylorus and the first and second parts of the duodenum, and (2) the making of an ample stoma.

The stoma must be large and must extend well below the level at which the common bile duct enters the duodenum through the papilla of Vater, to allow of a free and ready interchange of gastric and duodenal contents, thus counteracting any free hydrochloric acid which may be present in the stomach. Above all, it must be supple and free from any tension, and able to move facily with the contraction of its component parts.

The operation is started by mobilising the first and second parts and the commencement of the third part of the duodenum and of the pylorus itself by Kocher's method. This is accomplished by dividing the peritoneum and fascia propria on the outer aspect of the duodenum, by freeing any adhesions which exist, and by gently coaxing the bowel medialward with gauze or finger dissection. Unless a free and complete mobilisation can be achieved, the operation should be abandoned, as recommended by Finney, who attaches the utmost importance to this preliminary step.

When therefore the pylorus and duodenum have been freed and the abdominal field packed off with Lahey's waterproof pads (*J. Am. M. Ass.*, 104:1990, 1935), three sutures of fine silk are passed to act as guides and as tractors (fig. 30 [2]). The first is introduced close to the greater curvature of the stomach at a point about $3\frac{1}{2}$ inches below the pylorus, and then picks up a corresponding point on the inner border of the duodenum just about where the second part merges into the horizontal third part. This suture is tied and clipped with a hæmostat. The second suture is inserted immediately below the pylorus, while the third (the middle one) is placed midway between the other two, about the level of the ampulla of Vater. These sutures, too, are knotted and clipped. Two additional tem-

⁷ Finney, *Am. J. Surg.*, 40 121, 1933.

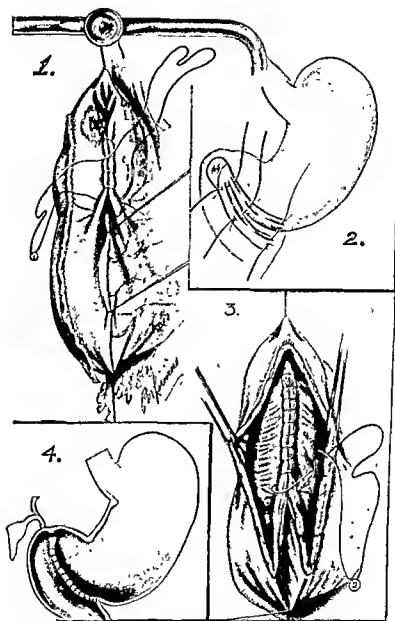


FIG. 30.—FINNEY'S OPERATION.

- (1) The first continuous posterior suture is being introduced.
- (2) The position of the three stay sutures and the horseshoe-shaped incision are depicted.
- (3) The second posterior through-and-through all-coats suture is being introduced. Note the position of the papilla of Vater.
- (4) Section through the stoma to show the large size of the stoma and the position of the papilla of Vater.

porary sutures are next inserted, one at the uppermost border of the pylorus and the other about 1 inch below the first guide suture, to sling to the buttons of a Lang's frame the portions of the stomach and duodenum to be anastomosed. Clamps are not used.

Traction is now made on the guide sutures while the first (posterior) continuous Lembert suture is introduced, commencing at the pylorus and ending just below the first guide suture. When this point is reached, the suture is laid aside for the moment, to be used again as the anterior invaginating stitch. An inverted U- or horse-shoe-shaped incision is made parallel with the posterior line of sutures through all the coats of the stomach, the pylorus and the duodenum. If an ulcer is found on the anterior wall of the duodenum it can be excised easily with scissors, as much scar tissue as possible being removed with it (fig. 30 [2]). If, however, there is an ulcer on the posterior wall, although it may be difficult to excise it, this is nevertheless possible by trimming away a triangular portion of the duodenal wall in which the ulcer is embedded. If a posterior wall ulcer is found to be very fixed to the underlying pancreas it may be destroyed with an electric cautery.

The posterior through-and-through (all-coats) suture is then applied, starting at the divided pylorus and proceeding downward to the lower angle of the incision (fig. 30 [3]). From this point it is carried upward without interruption as a Connell or loop-on-the-mucosa stitch, uniting the anterior edges of the stomach and duodenum and the divided pylorus, beyond which point it is tied (fig. 31[5]).

The first posterior seromuscular suture is then taken up again and continued anteriorly to reinforce and invaginate the first row of sutures (fig. 31[6]). A few interrupted stitches of fine silk are placed here and there where the suture line requires strengthening, and adjacent tags of omentum are drawn across to prevent the gut from adhering to the parietal peritoneum, the liver or the gall-bladder.

When the operation is completed it will be seen that the duodenum assumes its original position, dragging the stomach with it. The raw space on the outer surface of the duodenum occasioned by the preliminary mobilisation may with advantage be likewise covered with omentum.

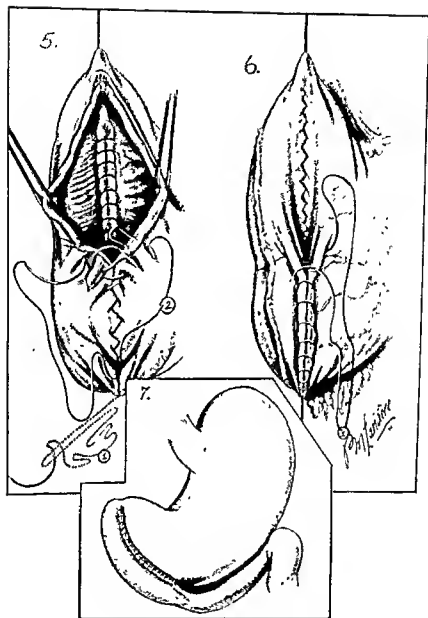


FIG. 31.—FINNEY'S OPERATION.

(5) The first anterior suture is being introduced as a loop-on-the-mucosa stitch.

(6) The second anterior suture is being introduced as a continuous Lembert suture.

(7) Appearance of the parts after operation.

Jaboulay's Sub-Pyloric Gastro-Duodenostomy. This is, in my opinion, an inferior operation to Finney's, although it had at one time the distinguished patronage of Moynihan and Wilkie. Wilkie (*Brit. M. J.*, 1:535, 1929) found that in reviewing 180 of his cases the results were excellent in 64 per cent, 25 per cent of the patients were relieved but not cured, and in 11 per cent symptoms of dyspepsia persisted. Two cases of stomal ulcer occurred and both patients received immediate and lasting relief from secondary gastro-jejunostomy. In two cases bilious vomiting continued after gastro-jejunostomy owing to axial rotation of the duodenum due to inadequate mobilisation. Here secondary gastro-jejunostomy was followed by good results.

It may be stated that the final results of this operation are on the whole not so good as those which can be achieved by gastro-jejunostomy and are definitely inferior to those which obtain after partial gastrectomy. I had the privilege of watching Wilkie perform a Jaboulay gastro-duodenostomy some weeks before his untimely death and also of discussing with him the place that this operation was destined to take in the treatment of chronic duodenal ulcer. He was of the opinion that it was a valuable procedure in women or elderly men suffering from chronic duodenal ulcer associated with low acid values, but that he would question its routine performance for other types of cases owing to the high incidence of late post-operative sequelæ. Finney, on the other hand, frequently employs Jaboulay's sub-pyloric gastro-duodenostomy when his own pyloroplasty is contra-indicated, as he deems the operation a rational and sound undertaking.

TECHNIQUE OF JABOULAY'S GASTRO-DUODENOSTOMY. The first step, as in Finney's operation, consists of mobilising the duodenum by Kocher's method (fig. 32 [1]). Two tractor sutures are then inserted. The first is passed close to the greater curvature of the stomach just short of the pyloric ring and picks up a point on the anterior wall of the duodenum immediately underneath the scarred area of the bulb. The second stitch is introduced near the greater curvature about $3\frac{1}{2}$ inches away from the pylorus, and picks up a point on the inner side of the lowest portion of the second part of the duodenum. When these sutures are tied and slung to the Lang's frame, the whole of the second portion of the duodenum and some 3 inches or so of the



FIG. 32.—JABOULAY'S OPERATION.

- (1) The duodenum is being mobilised by Kocher's method.
- (2) The adjacent portions of the stomach and duodenum are held in Allis forceps and are ready to be anastomosed.

anterior wall of the vestibule of the stomach are snugly drawn together side by side and are ready for the process of anastomosis (fig. 32[2]).

The use of clamps is unnecessary, in fact they are often cumbersome. Two continuous sutures are used for making the anastomosis; the first is a seromuscular stitch which unites the adjacent portions of the stomach and duodenum, while the second is a through-and-through hæmostatic suture which is inserted after the stomach and duodenum have been incised (fig. 33). This latter stitch is carried anteriorly after the posterior sutures have been inserted, and approximates the anterior margins of the stomach and duodenum, while the first stitch further invaginates the anterior suture line (fig. 33[2]).

At the end of the operation the scarred area of the bulb is invaginated and covered with omentum. If, at the completion of this type of gastro-duodenostomy, the stoma appears unduly small or if, owing to inadequate mobilisation, there is compression, rotation, or other evident mechanical defect at the site of anastomosis, it is good practice to supplement the procedure by performing posterior gastro-jejunosomy.

The immediate post-operative stage is often turbulent; there is much epigastric pain, intermittent colicky attacks, sometimes associated with meteorism and vomiting due to the fact that on account of the spasm and œdema of the stoma the stomach is unable for the time being to pass an adequate amount of its contents into the duodenum. Instant relief will be afforded by passing a stomach tube and applying constant suction for a day or two, and by supplementing this with intravenous saline solutions to make good the fluid and chloride loss.

Gastro-Jejunosomy. The place of gastro-jejunosomy in the treatment of peptic ulcer and the technical details of the operation are considered on page 334, but it may be said here that in so far as duodenal ulcer is concerned this operation is only advised under the following conditions:

1. In the presence of organic pyloric stenosis due to a stenosing ulcer accompanied by a marked reduction or absence of hydrochloric acid in the gastric juice. This will always remain the prime indication for the operation.

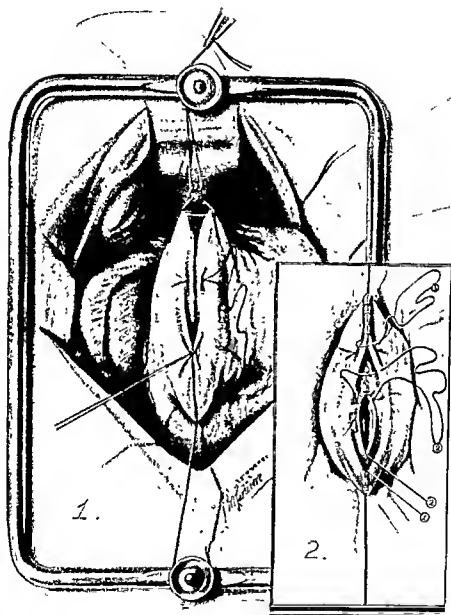


FIG. 33.—JABOULAY'S OPERATION.

A Lang's frame is being used and the principal steps of the anastomosis are depicted.

2. In elderly feeble patients of both sexes, in addition to those suffering from associated diseases.

3. Where for mechanical or other technical reasons partial gastrectomy, although indicated, is not feasible; but I venture to state that feasibility increases with familiarity.

4. Where in the absence of obstruction and of gastritis and following medical treatment the acid values of the gastric juice remain persistently subnormal.

5. Where following perforation of a chronic anterior wall ulcer associated with a considerable degree of scarring and deformity, closure of the hole has led to a *complete* occlusion of the lumen of the gut. Here, gastro-jejunostomy becomes obligatory.

When applied to the non-obstructive type of lesion in young patients and to those in whom there is an excess of free hydrochloric acid and a stomach which empties with vigorous rapidity, it is a pernicious procedure owing to the high incidence of anastomotic ulcer which follows.

Partial Gastrectomy. All gastrectomies are based upon the principles of the Billroth methods. They are, in fact, descendants of the Billroth I and Billroth II operations, being resections with gastro-duodenostomy or resections with gastro-jejunostomy. The modifications of the original Billroth I operation, which I will describe, are as follows:

1. von Haberer.
2. Mayo.
3. Finochietto.
4. Horsley.
5. Shoemaker.
6. von Haberer-Finney (fig. 34).

The modern Billroth II operations are named after Polya. They may be anterior when the proximal jejunal loop is brought over the colon (ante-colic) for anastomosis with the gastric stump, and posterior when the stoma is retro-colic.

Numerous techniques have been evolved and there are many claims to originality. But it would appear that the various derivatives of the Billroth II method which survive today owe their existence to the pioneer work and the skill of Mikulicz, Krönlein, Hoffmeister

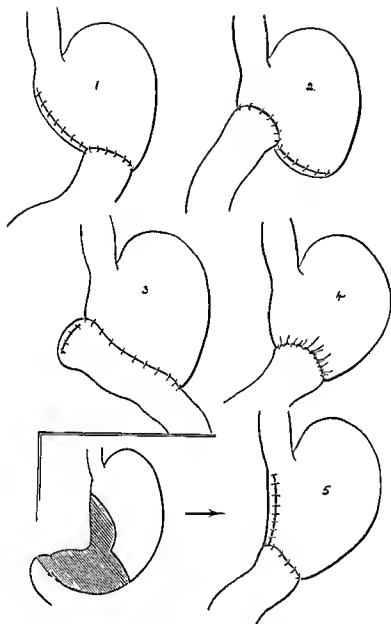


FIG 34—THIR. VARIOUS TYPES OF BILLROTH I OPERATION.

(1) Billroth I. (2) Horsley. (3) von Haberer-Finney. (4) von Haberer. (5) Shoemaker.

and Riechel. Polya was one of the first to write about the technical details of the operation, while Moynihan, W. J. Mayo, Sherren, Finsterer, Balfour, Lake and Pauchet were quick to observe the enormous advantages of this procedure and added their modifications with gratifying results.

We name certain operations after certain well-known surgeons, merely because it is customary and more convenient, and it is often the best known sponsor rather than the originator of a certain operation who receives all the praise and credit.

What are the objects of partial gastrectomy? Why should such an extensive and—to use an inappropriate word—mutilating operation prove necessary to cure such a small lesion? The objects may be briefly stated as follows:

(a) To remove an extensive area of the acid-secreting portion of the stomach, together with the pyloric segment and where possible the major portion of the first part of the duodenum together with the ulcer in order to reduce acid production.

(b) To make a new opening between the stomach and duodenum or between the stomach and proximal jejunum in order to restore gastro-intestinal continuity and to afford an admixture of gastric and intestinal contents.

The objects are achieved with brilliant results by the modern Billroth methods in a high percentage of cases. It is most important to remove a large segment of stomach, in some instances as much as two-thirds or more, and it is desirable although not always feasible to excise the ulcer together with the major portion of the first part of the duodenum. The proximal line of transection should extend from a point on the lesser curvature, some 2 to 2½ inches from the cardiac orifice, across the body of the stomach to a point on the greater curvature where the left gastro-epiploic artery sweeps through the diaphanous gastro-splenic omentum to anastomose with the right gastro-epiploic artery. The distal line of section will vary in individual cases. Where the ulcer can be freed from the adherent pancreas, or where the duodenum can with safety be dissected away from the ulcer which is left embedded in the pancreas, then the distal line will cut across the duodenum just below the ulcerated area; but where the bulb is so fixed to the pancreas by a penetrating ulcer and inflammatory adhesions that duodenal occlusion would prove too

hazardous, then distal transection should be carried out through the antrum. When the latter method is enforced on technical grounds, Bancroft's procedure (*Am. J. Surg.*, 16:223, 1923) of removal of the pyloric mucous membrane is undertaken. As I have said, it is not always possible or safe to remove the ulcer, but where it can be done without undue risk it is preferable to do so.

I must repeat that it is essential to resect at least two-thirds of the stomach; a niggardly gastrectomy is false conservatism as it will have no effect in reducing the gastric acidity and may even favour the production of secondary ulceration. The smaller the amount of stomach removed the easier becomes the operation but the worse will be the final results. Such limited resections should be termed pylorectomies and have no place in the treatment of peptic ulcer. Provided the proximal transection has been high it would seem immaterial whether the small gastric stump is anastomosed to the duodenum or to the jejunum, as both methods fulfil all requirements. But the Billroth I types of gastrectomy for duodenal ulcer have been criticised on these grounds:

1. The surgeon is likely to be more concerned about an easy approximation of the stomach to the duodenum than with a wide excision of the stomach, as the wider the excision the more difficult the suturing will be while making the necessary anastomosis.

2. When the anastomosis is completed the parts are often fixed, tense and strained, a state of affairs incompatible with good functioning.

3. As a result of longstanding ulceration the first portion of the duodenum is shortened and often the seat of widespread duodenitis; again, even when it can be mobilised freely, the part that remains after removal of the ulcer-bearing area, together with the surrounding zone of inflammation, is always short and somewhat inaccessible.

4. The duodenum is a soft and friable structure and devoid of peritoneum on its posterior aspect, and it is for these reasons that special precautions should be taken when fashioning the stoma to prevent fistula formation, leakage, peritonitis or the production of a valve or extreme narrowing of the new opening.

Nevertheless, when due care is taken in the mobilisation of the duodenum and of the stomach and when the suturing is carried out meticulously so that tension is obviated, the results, as shown by

such exponents as Walton, Grey Turner, von Haberer, Waltman Walters and others, are most eminently satisfactory. The opponents to any type of gastric resection for duodenal ulcer base their opposition on the following opinion: (1) That it is accompanied by a high death-rate; (2) that it is followed by anæmia and decreased economic efficiency; and (3) that it does not wholly protect the patient from possible subsequent stomal ulceration.

In cases of duodenal ulcer the resection has to be radical as it is planned for acid reduction; but it can hardly be described as mutilating, and "thorough" would be a more accurate word. The advocates of gastro-jejunostomy should bear in mind that when this operation is performed it is *functionally* almost as radical as gastrectomy in that the major portion of the right half of the stomach is permanently thrown out of action and receives no food, and that the pylorus ceases to function as a sphincter.

I cannot accept the statement which has been copied from one text-book to another that the mortality of partial gastrectomy for chronic duodenal ulcer is from 5 to 6 per cent. The following recent statistics belie this: Roscoe Graham had two deaths in 135 cases—1.4 per cent; while Engel (*South. Surg.*, 6:231, 1937) writes that Konnecke reported 468 resections with a 1.9 per cent mortality and that von Haberer in his last 100 consecutive cases had no fatalities. Pannet (*Surg., Gynec. & Obst.*, 67:493, 1938) by employing the Moynihan modification of the Polya method reported 116 cases with one death—0.86 per cent. In a personal series of 71 partial gastrectomies for chronic duodenal ulcer dating back to May 1934, there has been one death.

I am also quite at a loss to understand how it is that some surgeons, notably Morley, find that the incidence of anæmia is high following gastric resection. In those cases in which I consider it undesirable to resect the first portion of the duodenum with the ulcer, I perform transection of the vestibule and strip away the mucous membrane up to the pyloric ring and then excise it, after which the pylorus is closed over and a high gastric resection and anastomosis carried out after Hoffmeister-Finsterer's technique. The pyloric mucous membrane is removed, as I believe it is the source of a hormone—gastrin—which stimulates acid gastric secretion. The so-called anti-anæmic factor does not solely originate here. It is also

found in the region of the cardia, while in the first and second parts of the duodenum it is abundantly sufficient for the needs of the organism. Slight degrees of anæmia are compatible with good health and are easily corrected with adequate doses of iron and essential vitamins. It is only on the rarest occasions after numerous hæmatological investigations carried out upon patients shortly after gastrectomy, and months or even years after the performance of this operation, that I have observed this complication which, on being reported, was immediately treated and soon corrected by the simplest methods of dieting and by the administration of ferrous salts.

The macrocytic type of anæmia may occur after any type of gastric operation, including gastro-jejunostomy, as Hartfall (*Guy's Hosp. Rep.*, 84:448, 1934) has shown. He considers that the amount of stomach removed has no constant relation to the development of anæmia and that the anæmia is dependent upon the functional disturbance produced by the operation in the particular case. He is also of the opinion that the presence or absence of free hydrochloric acid does not seem to affect the development of this condition, the incidence of which has been greatly magnified.

The majority of my gastrectomy patients are back at work within three months of the operation. They are then instructed to eat small meals at frequent intervals and to avoid alcohol and smoking; but later on they are allowed an ordinary full diet, and seem to suffer no inconvenience or discomfort from this; in fact they rapidly gain in weight and strength and lead normal lives without any special restrictions. It is nonsense to say that a patient who has had a partial gastrectomy performed for ulcer must be as careful as one who is under medical treatment, as one great advantage of the operation is that it sets him free from all the trammels of invalidism. The final results leave little to be desired, and fully 90 per cent of the patients are restored to full economic efficiency. A few patients after the Polya types of partial gastrectomy will complain of a sensation of fullness after meals. This is not due to the small size of the remaining gastric pouch but rather to a technical flaw which permits of the influx of gastric chyme into the afferent limb of jejunum and then into the duodenum, leading to gaseous distension and overloading. This does not occur when the stoma is correctly fashioned and provision made to prevent this unpleasant complication.

Jejunal ulceration may occur after partial gastrectomy; in fact, if the gastric resection is timorous and limited to the pyloric segment, the incidence may be as high as it is after gastro-jejunostomy. It is high, too, when the mucous membrane of the pyloric portion is left behind when performing the Finsterer type of physiological operation, *i.e.*, partial gastrectomy with pyloric occlusion.

From the available statistics before me it would appear that with our improved methods of technique the incidence of jejunal ulcer after partial gastrectomy is rare—about 2 per cent. Engel states that Friedmann in a series of 2,250 gastric resections after a careful follow-up found a recurrence of 4 per cent in his earlier cases but only 0.5 per cent after he had performed a more radical type of operation.

The indications for partial gastrectomy are as follows:

1. Those cases in which there is a non-obstructive lesion associated with hyperacidity, hyperperistalsis and hypersecretion, in addition to which pain is difficult to relieve and relapses are becoming increasingly frequent.

2. The recurrent type of spastic pyloric stenosis accompanied by hyperchlorhydria.

3. Combined ulcers.

4. Bleeding penetrating ulcer of the posterior wall when local and general conditions permit.

5. Recurrence of ulceration following an inadequate operation, such as pyloroplasty.

TECHNICAL DETAILS OF THE OPERATIONS.—**Billroth I** Types of Repair. The decision to utilise the Billroth I type of repair depends upon the mobility of the upper and lower segments and whether they can be brought together without undue tension. Here the surgeon has a large choice of operations. He may anastomose the whole of the cut end of the stomach to the cut end of the duodenum (von Haberer); he may close the upper half of the cut end of the stomach and employ the lower half for union with the duodenum (Mayo; Finochietto); he may anastomose the duodenum to the upper half of the cut end of the stomach and close the lower half toward the greater curvature (Horsley); he may implant the cut end of the gastric pouch into the second portion of the duodenum (von Haberer-Finney); or he may perform Shoemaker's operation (see fig. 34[5]).

If the diameter of the remaining gastric stump is narrow then von Haberer's operation is obviously the best and safest procedure. I have employed the von Haberer-Finney operation for cases of duodenal ulcer associated with duodenal ileus, and duodeno-jejunostomy is carried out at the completion of the operation to overcome duodenal stasis. I have also found it invaluable in certain cases of jejunal ulceration following pylorotomy or partial gastrectomy for duodenal ulcer. The technical beauty and ease of performance of Finochietto's operation has always endeared it to me, and when I am constrained to carry out a Billroth I type of repair I almost invariably choose this one.

I have no experience of Shoemaker's operation for duodenal ulcer, although I have on occasion employed it with unhappy results for chronic gastric ulcer on the lesser curvature.

1. *Von Haberer's Method.* Here the vascular epiploic arch is preserved and is detached intact from the major portion of the greater curvature by ligaturing and dividing the numerous small branches which supply the stomach. The right and left gastric arteries are divided in mobilising the stomach, while the pancreatico-duodenal artery will be ligated when the duodenum is being separated from the pancreas. A small Payr clamp is then applied to the duodenum, distal to the ulcer, while a large Payr clamp crushes and grasps the body of the stomach as high up as possible, the tips of the blades being about 3 inches from the œsophagus while the portion embracing the greater curvature lies close to the lower pole of the spleen.

The intervening portion of duodenum and stomach is divided with a diathermy knife, close to the blades of the Payr clamps, and removed, after which the upper and lower segments in the grasp of the clamps are approximated. By everting the blades of the clamps, the posterior surface of the duodenum and the posterior wall of the stomach come to lie together, and are ready to be approximated by a series of interrupted fine silk sutures.

Enterostomy clamps are next applied to the duodenum and stomach, distal to the Payr clamps which are now removed, and after trimming away the crushed areas of the duodenum and stomach which have been produced by the Payr clamps, the posterior lips of the duodenum and stomach are drawn together with a continuous hæmorrhagic suture which commences on the greater curvature and

proceeds upward without interruption toward the lesser curvature where on turning the corner it is converted into a Connell stitch which unites and inverts the anterior margins of the duodenum and stomach.

When the suture reaches the greater curvature it is tied at the point where it started. It is important for each suture on the stomach side to take a little larger bite and to be spaced a little bit further from its neighbouring sutures as compared with the corresponding suture in the duodenum. Thus the small duodenal fragment can be fitted snugly to the larger gastric fragment (see fig. 34[4]).

The operation is completed by introducing a few interrupted sutures of fine silk to reinforce the anterior suture line and by drawing the wisp of omentum over it to prevent adhesions from forming in this area.

2. *Finocchetto's Method.* This surgeon attaches the greatest importance to the most liberal mobilisation of the duodenum. In a personal communication he writes:

Instead of dissecting the peritoneum and the outer border of the duodenum, I commence by severing the filamentous bands and adhesions over the very middle of the gut by means of a blunt instrument, and by enlarging the opening thus made both upwards and downwards. Along this outer border of the duodenum the mobilisation proceeds until the colon is displaced downwards. The duodenum, when freed, can be turned over and carried towards the middle line. Behind it can be seen the inferior vena cava in all its width and about $\frac{7}{8}$ cms. of its length. The adhesions and bands are firmer and more vascular at the upper part, where most of them require two ligatures. The freed duodenum permits of a more thorough examination of any duodenal ulcers which may be present, of the head of the pancreas, and of the structures contained in the right border of the gastro-hepatic omentum. It is very dangerous to remove any portion of the pancreas whilst resecting a peptic ulcer; if, therefore, an ulcer has penetrated the pancreas it is best to sacrifice a portion of gut and to leave the ulcer attached to the pancreas, rather than to attempt local excision of a portion of the gland.

In actual practice, if I cannot free the duodenum well away from the gland, I often desist from this type of operation.

Before proceeding further with the operation and after ensuring a complete hæmostasis, I place a gauze swab to cover the raw surface which has resulted from the mobilisation of the duodenum, and this swab I leave in position, not removing it until the operation is nearly complete.

Next comes the division of the right part of bothomenta. Ligatures are placed on each vessel before it is cut. The vessels are tied in continuity. The



FIG. 35.—FINOCHIETTO'S TECHNIQUE OF THE BILLROTH I TYPE OF REPAIR.

- (1) The stomach and the duodenum have been extensively mobilised. The author's special clamp is applied to the duodenum just distal to the ulcer.
- (2) The duodenum is being divided between clamps.

vessels attached to that portion of the stomach or duodenum about to be resected are ligatured and tied with two knots, and a little further away two ligatures are placed on the same vessel, each tied with three knots.*

Figure 35 shows the stage in the operation when the stomach and duodenum have been completely mobilised and the author's special duodenal clamp is being applied to the duodenum, distal to the ulcer. In the inset, the duodenum is shown as being cut across. The further steps of Finochietto's method are so clearly depicted in figures 36 and 37 that a detailed description here would be superfluous; but the reader should observe how particular he is to free the seromuscular layers from the underlying mucosa on the gastric side prior to inserting the long continuous master suture, and how this suture is applied.

Finochietto has performed this operation in more than 300 cases with only three fatalities, and assures me that the late results have been uniformly good.

3. *Mayo's Method.* In this operation the numerous small blood vessels on the upper (gastric) side of the epiploic arch are individually seized, ligatured and divided in order to free the greater curvature, after which the right and left gastric arteries are isolated, doubly ligated, and cut so that the lesser curvature may be mobilised. A large Payr clamp is next applied longitudinally across the body of the stomach, as high up as possible, on a line indicated on the inset of figure 38. Another Payr clamp is placed parallel to this, but on the distal or pyloric side, and the stomach is transected between them with a diathermy knife. The distal portion of the stomach with its attached clamp is covered with a waterproof square and drawn over to the right, thus exposing the pancreas and posterior surface of the pylorus and the commencement of the first part of the duodenum. The upper half of the margins of the gastric pouch embraced by the Payr clamp are then oversewn and invaginated as is well depicted in figures 38 and 39, while the snout that results at the greater curvature is trimmed away in order to facilitate the anastomosis of this region of the stomach with the first part of the duodenum.

The most difficult stage of the operation is the freeing of the duodenum and the control of the many anomalous small blood vessels which exist between the head of the pancreas and the posterior wall

* Finochietto, Personal Communication.

of the bulb, especially in the neighbourhood of the ulcer; but with caution and patience each strand is isolated, doubly ligated, and divided before proceeding with the next step. When the duodenum has been rendered sufficiently mobile, it is approximated to the stomach and the anastomosis is carried out as shown in figure 40.

4. *Horsley's Method.* In the modification described by Horsley

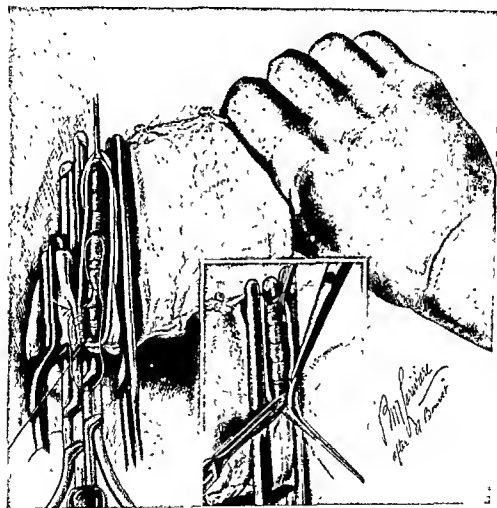


FIG. 36.—FINOCCHIETTO'S TECHNIQUE OF THE BILLROTH I TYPE OF REPAIR.

The first through-and-through posterior continuous suture is being introduced. Note that the gastric mucous membrane is not included in this suture.

The inset shows the seromuscular coat of the stomach being divided anteriorly down to the mucous membrane. The dotted line indicates the line along which the mucosa will subsequently be divided.

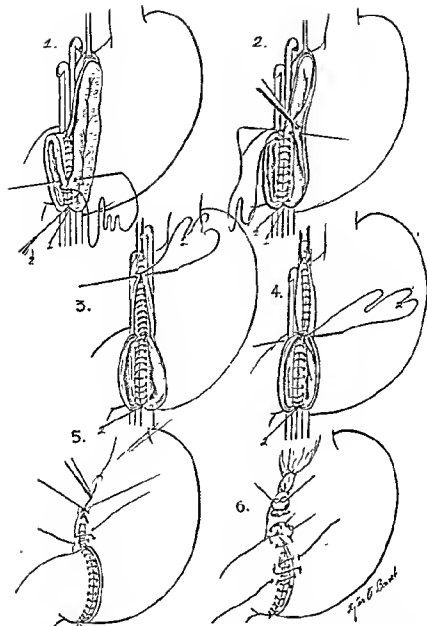


FIG. 37.—FINOCCHIETTO'S TECHNIQUE OF THE BILLROTH I TYPE OF REPAIR.

- (1) The second continuous through-and-through suture is being introduced.
- (2) When the second continuous suture has reached the upper end of the duodenum it picks up both margins of the gastric mucous membrane.
- (3) The continuous suture on returning approximates the seromuscular edges of the stomach.
- (4) The continuous suture has been completed down to the lower margin of the duodenum. The lesser curvature is being reconstituted and invaginated by a series of interrupted cross-sutures.
- (5) The anterior edge of the seromuscular coat of the stomach is being sutured to the anterior wall of the duodenum by a series of interrupted cross-sutures. A purse-string suture is inserted to close the so-called dangerous angle.



FIG. 38.—MAYO'S TECHNIQUE—BILLROTH I TYPE OF REPAIR.

The stomach has been clamped with a Payr enterotome and the organ transected and drawn well over to the right to display the under-aspect of the duodenum. The first portion of the duodenum is being mobilised by the division of the numerous bands which anchor this part of the duodenum to the pancreas.

The inset shows the amount of stomach and duodenum excised. The vascular epiploic arch is preserved.

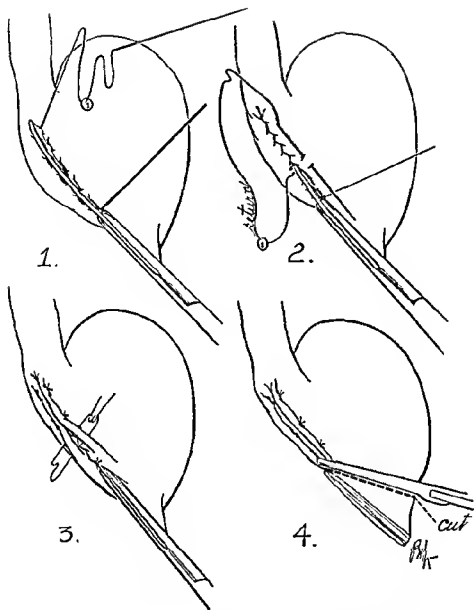


FIG. 39.—MAYO'S TECHNIQUE—BILLROTH I TYPE OF REPAIR.

The upper half of the cut end of the stomach is oversewn and securely invaginated in the manner illustrated. The projecting snout at the greater curvature is excised to simplify the anastomosis of the lower cut end of the stomach with the open end of the duodenum.

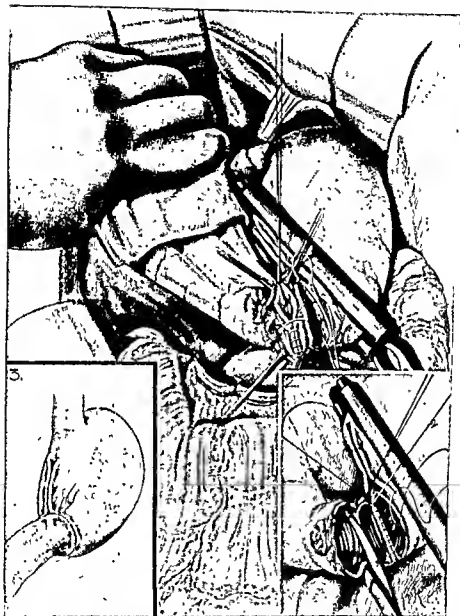


FIG. 40.—MAYO'S OPERATION—BILLROTH I TYPE OF REPAIR.

- (1) The first continuous posterior seromuscular suture is being introduced.
- (2) The duodenum is being cut adrift just as the second posterior all-coats through-and-through suture is about to be completed.
- (3) This shows the arrangement of the parts at the completion of the operation.

the lower half of the cut end of the stomach toward the greater curvature is closed and the open portion toward the lesser curvature is anastomosed to the end of the duodenum. The essential steps of this operation are illustrated in figures 41 and 42.

I have found this operation more difficult to perform than those which have already been described. It has always seemed to me that



FIG. 41.—HORSLEY'S MODIFICATION OF THE BILLROTH I TYPE OF REPAIR.

there is more stress upon the suture line when the anastomosis is made on the lesser curvature than when it is made on the greater curvature. For these reasons, when the Billroth I repair is indicated I prefer to make the anastomosis at the greater curvature because I

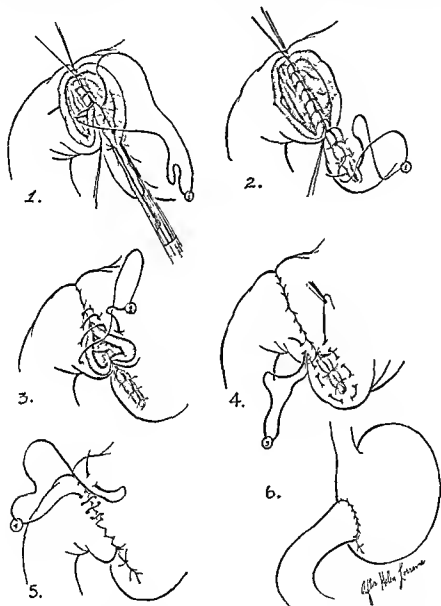


FIG. 42.—HORSLEY'S MODIFICATION OF THE BILLROTH I TYPE OF REPAIR.

The method of anastomosing the upper cut end of the stomach to the cut end of the duodenum is shown in detail.

feel that it is safer and simpler and has given symptomatic results as good as those of other operations.

5. *Von Haberer-Finney's Method.* In this operation the first part of the duodenum, the pyloric segment and a variable amount of the body of the stomach are removed. The duodenal stump is securely closed and the cut end of the stomach is anastomosed to the anterior aspect of the second part of the mobilised duodenum (see fig. 34[3]).

I have, as previously stated, employed this operation for chronic duodenal ulcer associated with duodenal ileus, adding duodeno-jejunosomy as a secondary procedure, and also in some cases of recurrent jejunal ulcer following partial gastrectomy, especially after that most damning procedure—Roux's anastomosis in Y.

The danger of axial rotation or flattening of the second portion of the duodenum against the spinal column or of kinking of the commencement of the third portion of the duodenum can be surmounted by a thorough mobilisation of the duodenum.

6. *Shoemaker's Method.* Here the duodenal bulb, the pyloric segment and the greater portion of the lesser curvature including a generous margin of anterior and posterior wall of the stomach are excised, often with the aid of special clamps such as those designed by Shoemaker, Morley or Souttar.

After the lesser curvature has been reconstructed, an end-to-end anastomosis is performed between the cut ends of the stomach and duodenum (see fig. 34[5]).

This operation is rarely employed for duodenal ulcer, although it has a definite field of usefulness in the management of gastric ulcer. Morley, for instance, performed this operation for ulcer of the body of the stomach in 119 cases with three deaths, a mortality of 2.5 per cent. These three deaths were all due to pulmonary complications. In his hands, when applied to cases of gastric ulcer, it is a safe operation yielding good clinical results.

Billroth II Types of Repair. The modern descendants of the Billroth II operation are termed anterior and posterior Polya partial gastrectomies. I shall first describe the technique of the standard operation and afterward give an account of the numerous modifications and indicate the conditions in which they should be employed.

THE STANDARD OPERATION

The operation is commenced by detaching the vascular epiploic arch from the greater curvature (fig. 43). The detachment should

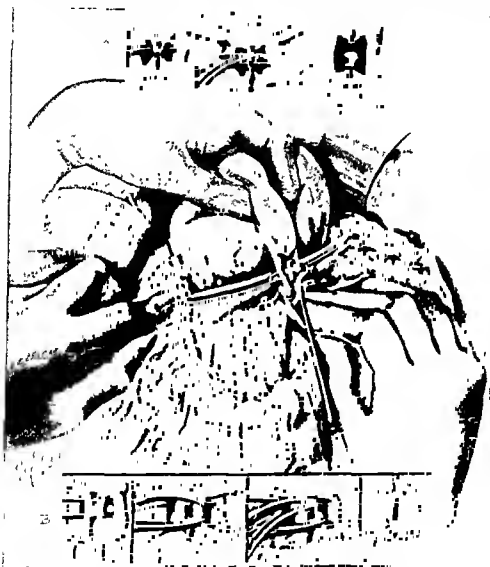


FIG. 43.—PARTIAL GASTRECTOMY FOR CHRONIC DUODENAL ULCER—THE STANDARD OPERATION.

The vascular epiploic arch is being detached from the greater curvature.

extend from the pylorus to the lowest margin of the gastro-splenic omentum where the left gastro-epiploic artery boldly swings to the

right. The blood vessels which arise from the upper part of the arch are numerous and small, while those from the lower convex side are few and smaller in size. The detachment may be effected by various methods, two of which are well shown in figure 43. A special grooved director is thrust under a small sheaf of vessels midway between the main artery and the greater curvature, and an aneurysm needle threaded with fine silk is used to simplify the ligaturing. These small vessels are carefully tied in continuity in two places and then divided. This process, which is slow but safe, is repeated step by step, first dealing with all the vessels to the right half of the greater curvature and then proceeding to ligation and division of the blood vessels which pass to the major portion of the left half of the greater curvature of the stomach.

When this step is completed, the pylorus and first portion of the duodenum are mobilised by underrunning the numerous vascular bands and adhesions on the superior, inferior and posterior aspects of the bowel. The adhesions which exist posteriorly are isolated with the director or with long non-toothed dissecting forceps prior to ligaturing and dividing them *seriatim* (fig. 44). When a posterior wall ulcer is attached to the pancreas, the dissection must needs be very cautious, or the pancreas may be inadvertently injured, the common bile duct opened, the duodenal wall punctured, or a brisk hæmorrhage produced by the laceration of a large vessel. There are untold and unnamed arteries which arise from the bed of the pylorus and which lie hidden in dense, stumpy, fibrous bands, and each of these must be individually ligatured.

The mobilisation of the duodenum will be facilitated by ligaturing and dividing the right gastric (pyloric) artery. Figure 45 illustrates how this is done. The proximal end of the artery is doubly ligated with strong silk, as any slipping of a ligature here would have serious consequences.

If a posterior wall ulcer has penetrated deeply into the pancreas, the duodenum should be dissected free, leaving the base of the ulcer adherent in the substance of the pancreas where it can be cautiously destroyed with an electric cautery.

It is necessary to free the duodenum for at least $\frac{1}{2}$ inch beyond the ulcerated area in order to leave sufficient healthy tissue for a generous inversion of its cut end. There are many ways of dealing



FIG. 41.—PARTIAL GASTRECTOMY FOR DUODENAL ULCER—THE STANDARD OPERATION.

Mobilisation of the posterior aspect of the first part of the duodenum.

with the cut end of the duodenum, three of which are depicted in figure 46.

In the average case, two straight clamps are placed on the duodenum, side by side, distal to the ulcer, and the bowel is divided between them, pains being taken to pack off the operative field, as

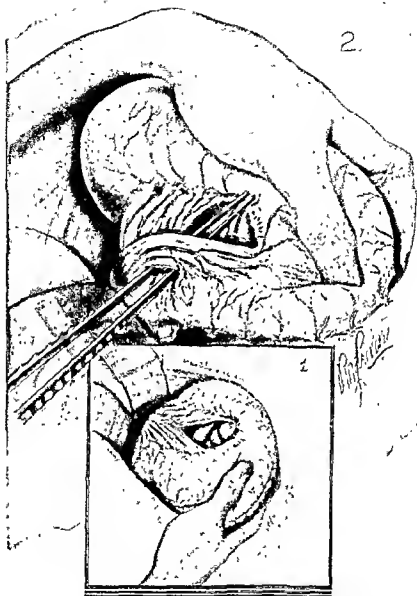


FIG. 45.—PARTIAL GASTRECTOMY FOR CHRONIC DUODENAL ULCER—THE STANDARD OPERATION.

The isolation and ligation of the right gastric (pyloric) artery.

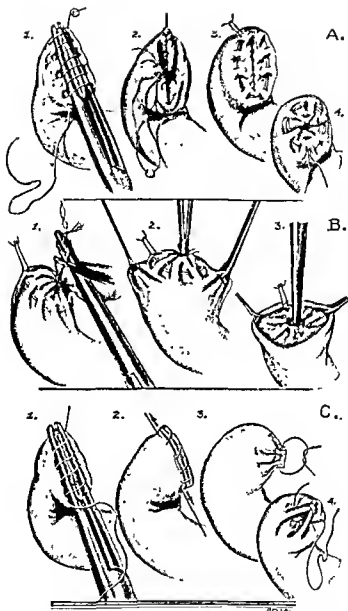


FIG. 46.—PARTIAL GASTRECTOMY FOR CHRONIC DUODENAL ULCER—THE STANDARD OPERATION.

Three methods of securely invaginating the cut end of the duodenum are shown. The preference is for Method B whenever possible.

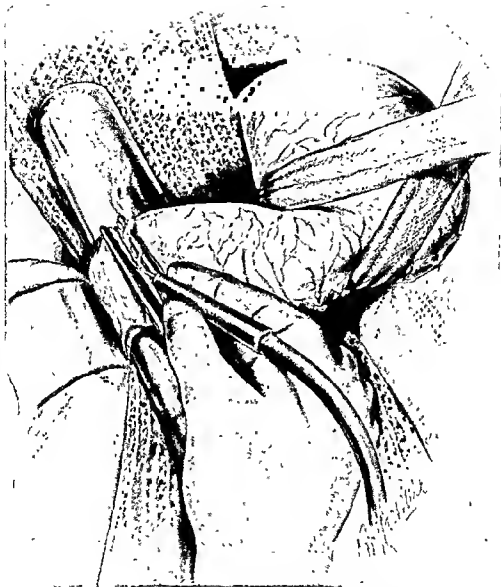


FIG. 47.—PARTIAL GASTRECTOMY FOR CHRONIC DUODENAL ULCER—THE STANDARD OPERATION.

The duodenum is being divided with a diathermy needle. Note how the operative field is carefully packed off; also the position of the Sargeant retractor.

shown in figure 47. A warm Cripps' pad is spread out underneath the duodenum and pyloric region, and on the top of this is placed a Sargeant retractor to act as a guard while the bowel is being transected. The clamp on the gastric side of the duodenum is covered with a waterproof square and drawn well over to the left away from the field of operation while the other clamp is rotated laterally to expose the under-surface of the duodenal stump which is then sutured over with a right-angled continuous stitch, this being drawn tight as the clamp is released. The stitch is carried back to the starting point and tied firmly, producing a purse-string effect, the suture line is further reinforced with a purse-string suture of fine silk, and pads of omentum are drawn across the sutured area and tied into position to afford the maximum protection against leakage (see fig. 46[A]).

Another method, much favoured by Finsterer, consists of inserting a purse-string suture of silk around the lowest portion of the first part of the duodenum, after which the duodenum is crushed with a clamp, slightly distal to the ulcer, and a stout ligature is applied around the crushed groove. Three pairs of Allis forceps are next applied to the duodenum beyond the purse-string suture to steady it; a clamp is applied $\frac{1}{4}$ to $\frac{1}{2}$ -inch proximal to the stout ligature, and the duodenum is divided with a diathermy knife (see fig. 46[B]). The duodenal stump is now invaginated with non-toothed dissecting forceps and the purse-string suture is tied (see fig. 46[B2]). Another purse-string suture may be introduced to invaginate the stump even further, and adjacent portions of omentum are anchored to the suture line to afford added protection. Method B is the suture preferred whenever possible.

Sometimes the duodenum is so shortened as the result of old scarring or the ulcerated area has encroached upon the second part to such an extent that it is impossible to effect the closure with the aid of clamps or forceps. In these cases it is best to cut across the bowel directly below the ulcerated area or below the gaping hole in the posterior wall where the ulcer was situated and to close the open end of the duodenum with an economic Connell suture, and when this is inserted to reinforce the suture line with a few interrupted sutures of strong silk.

When this step of the operation is completed, a warm moist pack is

placed over the duodenum to act as a temporary guard to the newly-sutured area.

The left gastric artery must now be securely tied. In cases of duodenal ulcer, this presents no difficulty, but in gastric ulcer, owing to inflammatory thickening and œdema of the lesser omentum, to the presence of large septic lymph glands, to fixation of the stomach to the liver or pancreas by an eroding ulcer, and to surrounding adhesions, it is often an anxious and arduous dissection. Sometimes infiltration of the gastrohepatic omentum with a little weak solution of novocaine will facilitate the isolation of this artery. In figure 48 three methods of ligaturing the left gastric (coronary) artery close to its origin are illustrated. A simple plan is to grasp between the index finger and the thumb of the left hand the remaining portion of the gastrohepatic omentum high up on the lesser curvature about 2 to 2½ inches from the cardia, and with the aid of the right thumb (and perhaps dissecting-forceps) to work a passage through between the lesser curvature and the artery itself until the index finger projects through the tissues. Through this rent a hæmostat is passed to act as a guide for an aneurysm needle which is threaded with a strong ligature. The first ligature is slipped downward toward the aorta and tied as close to it as possible. The ends of this ligature are left long and clipped with a hæmostat. A second ligature is again applied to the artery, close to the first, while a third is tied nearer to the lesser curvature so as to allow an area of fully ½ inch between it and the other two ligatures. Through this area (i.e., between the second and third ligatures) the artery is divided with scissors. The three-clamp method may also be employed, which consists of applying two hæmostats to the artery close to its origin, and another close to the lesser curvature, the artery being divided between the distal and middle hæmostats. The first artery forceps is removed, leaving the middle one in position, and the two ligatures are slipped into the groove and tied securely.

In order to obtain the optimum view of the artery, the surgeon should draw the stomach out of the way with the left hand and pull it over the left costal margin toward the left shoulder. The forceps or ligature which is grasping the lesser curvature end of the left gastric artery is now drawn downward toward the incisura to permit the glands and fatty tissues in this region to be dissected downward for

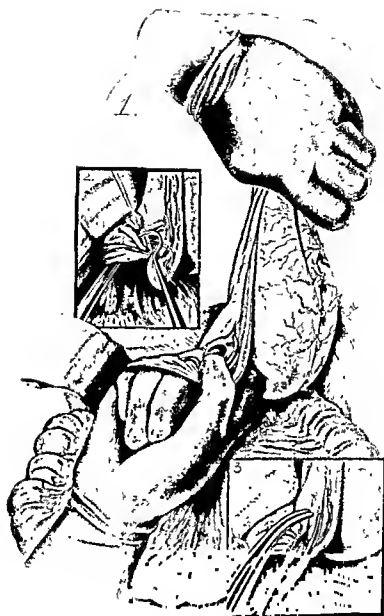


FIG. 48.—PARTIAL GASTRECTOMY FOR CHRONIC DUODENAL ULCER—THE STANDARD OPERATION.

Ligature of the left gastric (coronary) artery.

(1) The index finger of the right hand has been insinuated between the main branch of the left gastric artery and the lesser curvature of the stomach high up.

(2) The artery is being tied off with the aid of a curved director and an aneurysm needle.

(3) The three-clamp method of securing the left gastric artery.



FIG. 49.—PARTIAL GASTRECTOMY FOR CHRONIC DUODENAL ULCER—THE STANDARD OPERATION.

In the posterior operation the opening is made in the mesocolon through one of the wide avascular areas which exist to the right or the left of the middle colic artery.

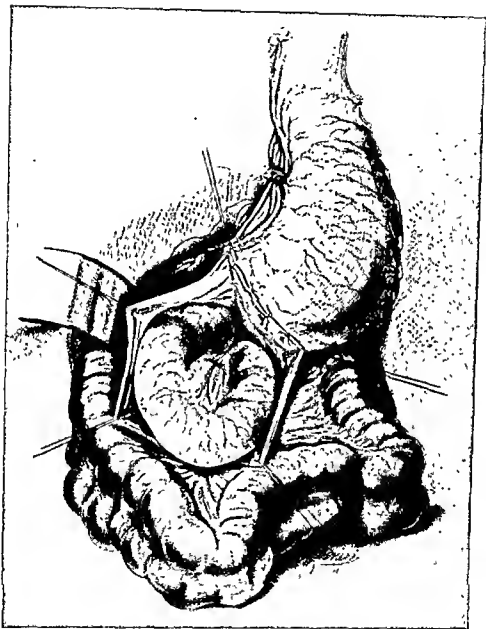


FIG. 50.—PARTIAL GASTRECTOMY FOR CHRONIC DUODENAL ULCER—THE STANDARD OPERATION.

In the posterior Polya operation the left margin of the mesocolon is stitched to the posterior surface of the stomach about 1 inch proximal to the proposed line of transection.

a short distance. In doing this a raw surface will result on the lesser curvature from the stripping of the peritoneum from this region, and this area should immediately be oversewn and re-peritonised with fine chromic catgut carried on a small curved atraumatic needle (see fig. 50). If this is done at this stage it will greatly facilitate the introduction of sutures in this region after the stomach has been cut adrift.

It will now be seen that the stomach is freely mobile and ready for anastomosis with the jejunum. The surgeon at this stage will have to ask himself three questions: (1) Should the anastomosis be made antecolic or retro-colic? (2) should the proximal end of the selected jejunal loop be applied to the lesser curvature or to the greater curvature of the stomach? and (3) should the upper half of the cut end of the stomach be closed or should the whole of the cut end of the stomach be utilised for fashioning the new stoma?

In most instances it is better to make the stoma posterior or retro-colic, as a shorter loop of proximal jejunum can be employed with the obvious advantage that it is closer to the duodenum. But it may be impossible to make use of this method when the mesocolon is laden with fat which obscures the middle colic blood vessels, when it is short, when the vascular arches are numerous and bizarre in formation, or when inflammatory or developmental adhesions fasten the first few inches of the proximal jejunum to its surface. In such cases the surgeon should not hesitate to employ the anterior method of anastomosis, as it is simple and efficient, and yields equally as good results as the retro-colic method.

When the *anterior* method is chosen, the transverse colon is drawn upward through the wound to display its undersurface and the duodeno-jejunal flexure. It is always a wise precaution to identify the duodeno-jejunal flexure by sight, after which the first 12 inches or so of the commencement of the jejunum are gently drawn through the abdominal wound. The omentum and transverse colon are tucked away under the liver and into the now empty stomach bed, and when this is accomplished the stomach and jejunum are prepared for anastomosis.

In my opinion it is better to apply the proximal end of the segment of jejunum selected for anastomosis to the lesser curvature rather than to the greater curvature, as the small gastric segment

which remains after gastrectomy is to all intents and purposes an inert pouch devoid of strong peristaltic movement and the food and fluids which enter it spill over by force of gravity to the greater curvature and enter the intestine in this region.

When the stoma has been fashioned as I suggest, nourishment is transferred directly into the long tube of intestine where it is eagerly passed on and churned up without much ado. When, however, the proximal end of the jejunum is applied to the greater curvature, as by the Moynihan method, most of the food soon finds its way into the duodenal cul de sac where, on account of its bulk and fermentation, it distends the gut and gives rise to many unpleasant sensations such as epigastric distress and bloating, tightness and even colicky pains. The patient feels full even after a small and inadequate meal. This distress passes off in time when the duodenum rejects its heavy, glutinous and gaseous contents back into the stomach and the patient belches up a quantity of wind.

The loop, then, is applied from the right to the left across the stomach with the proximal end to the lesser curvature and the distal end to the greater curvature. How long should the proximal loop be? The length of the loop is measured from the duodeno-jejunal flexure to the proximal point in the anastomosis, *i.e.*, from the flexure to the lesser curvature. The length will vary in individual cases, but it must never be so short as to cause dragging or tension at the line of suture, flattening of the loop, compression of the colon (when the anterior method is employed), kinking of the gut at the mesenteric root or at the lesser curvature, or as to prevent the gastric segment from riding freely upward toward the diaphragm. A loop that is too short has two inherent dangers—peritonitis from leakage, and obstruction from the factors enumerated above. The loop must not be too long, or the proximal jejunum will become overloaded and have great difficulty in emptying itself through the stoma. Vomiting is the bugbear of the long loop. It must, furthermore, never be so long that an entero-anastomosis becomes obligatory (see fig. 53[3], inset), as through this secondary opening the alkaline juices are shunted into the intestine away from the newly-fashioned gastro-enteric stoma which now receives the full force of the acid bath.

It follows from this that great importance is attached to choosing—and choosing wisely—the exact place in the proximal jejunal loop

for the making of the anastomosis. In the average case the length of loop is about 4 to 5 inches when the retro-colic route is chosen, and 6 to 8 inches when an anterior anastomosis is being undertaken. The loop must be free and easy; there must be a great deal of slack; the parts engaged in the anastomosis must lie comfortably together without any tension; the proximal portion of the loop must curve gracefully upward to its point of attachment to the lesser curvature; and the new stomach must be capable of sliding upward toward the deep recesses of the diaphragm without restraint (see fig. 53).

When the proximal point is selected, it is picked up with Allis forceps and laid aside for the moment while the line of transection of the stomach is considered. If at this stage of the operation the stomach is distended with gas and fluid, a tube is introduced into the viscus through a stab wound made in the posterior wall near the vestibule, and suction is applied until the stomach is empty and its walls fall flaccidly together. Before withdrawing the suction tube, the small stab wound is surrounded with a purse-string suture and tied, and the tube is withdrawn (see fig. 51[1]).

The stomach should now be firmly drawn well over the left costal margin in an upward and outward direction, thus exposing the full face of its posterior surface. The line of transection is marked off by fixing a pair of Allis forceps on to the lesser curvature about 2 inches or so below the œsophagus to act as a guide, and by clipping another one high up on the greater curvature in the region prepared for the anastomosis, which is close to the lower margin of the gastro-splenic omentum.

In the *posterior* operation a generous opening is made in the mesocolon through one of the wide avascular areas which exist to the left of the main branch of the middle colic artery, in the manner shown in figure 49, and the proximal jejunal loop is drawn into the supra-colic compartment. The left margin of the mesocolon is stitched to the posterior surface of the stomach about 1 inch proximal to the proposed line of transection (fig. 50), and when the anastomosis is completed the right margin of the mesocolon is fixed to the anterior surface of the stomach, $\frac{1}{2}$ inch above the anterior row of sutures (see fig. 52[12]), thus placing the stoma in the infra-colic compartment of the abdominal cavity.

In making the anastomosis, four rows of sutures are used. The first

posterior row of interrupted sutures of fine silk is inserted with great care to prevent axial rotation of the posterior continuous sutures. Three continuous sutures of No. 0 twenty-day chromic catgut threaded on atraumatic curved needles are used, but there can be no objection to the employment of only two rows of sutures provided the stitching is carried out accurately.

The first continuous posterior suture, which starts at the greater curvature, is a right-angled stitch of the Halsted type, and approximates the adjacent margins of the jejunum and stomach. When it reaches the lesser curvature, particular care is taken to place one or two closely applied locking sutures (fig. 51).

An incision extending from the lesser to the greater curvature is now made through the seromuscular coats of the stomach, down to the mucosa, about $\frac{1}{4}$ inch distal to the suture line, and the numerous blood vessels which are displayed lying on the submucosa are individually underrun and tied as they emerge from under the seromuscular flap that lies closest to the line of sutures (fig. 51[4]). This is the surest method of controlling bleeding from the stomach and keeping the field of operation neat and tidy.

The seromuscular coats of the jejunum are likewise incised for a length corresponding to the incision in the stomach, and any brisk bleeding points are controlled with a ligature (fig. 51[4]).

The second posterior suture, which is a through-and-through all-coats stitch, starts at the greater curvature and finishes at the lesser curvature, where it is locked (fig. 51[6]). The mucous membrane of the jejunum is incised for the full length of the incision and the interior of the intestine is swabbed and cleansed with small swabs which have been soaked in warm normal saline. The mucosa of the stomach is punctured and a suction tube inserted through the hole to withdraw any remaining gastric secretion, after which the mucosa is divided for the full length of the incision (fig. 51[6]).

The third posterior suture approximates the cut edges of the mucous membrane of the stomach and jejunum, and when it reaches the lesser curvature it is—like the former two sutures—locked (fig. 51[7]). A large square pack is placed over the gaping mouths of the stomach and intestine, and the stomach is turned over to the right, as it were on a hinge, to expose its anterior surface where a transverse incision is made with a knife down to the mucosa to permit of easy

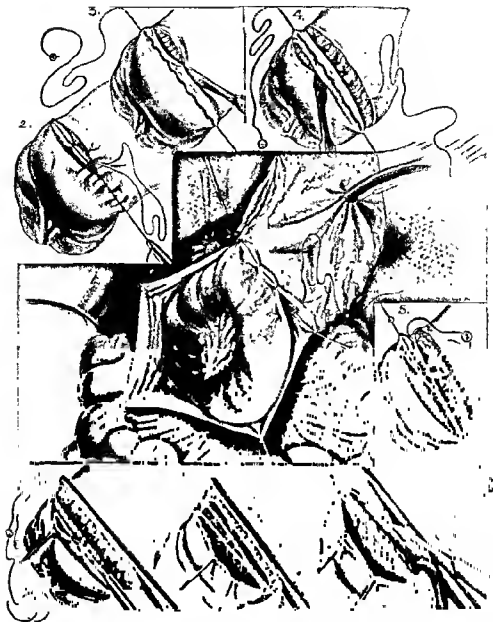


FIG. 51.—PARTIAL GASTRECTOMY FOR CHRONIC DUODENAL ULCER—THE STANDARD OPERATION.

The posterior Polya operation being conducted without the aid of clamps. The details of the suturing of the individual layers of the stomach and jejunum whilst making the anastomosis are shown step by step.

ligaturing of the numerous vessels which are found here. At the lesser and greater curvatures this incision joins the now sutured posterior margin.

The stomach is put on the stretch and cut adrift by snipping through the mucosa with scissors. The third posterior stitch is continued as the first anterior stitch, and unites the cut edges of the mucosa of the stomach and jejunum, and when it reaches the greater curvature it is knotted to the point where it started (fig. 52). Likewise the second posterior stitch, on turning the corner at the lesser curvature, picks up all the coats of the anterior margin of the stomach and of the anterior margin of the jejunum, and proceeds to the greater curvature where it is tied.

The third anterior suture finishes as it started, *i.e.*, as an inverting seromuscular Cushing stitch (fig. 52[11]).

When the anastomosis is completed, a few interrupted sutures of fine silk are placed here and there on the anterior suture line, and especially in the region of the lesser curvature, to afford additional security (fig. 53).

Should the whole of the cut end of the stomach be utilised in the anastomosis?

When the stomach is very stretched or very large for any reason, it is better to close the top half, *i.e.*, the side toward the lesser curvature, and to make the anastomosis to the lower half of the cut end of the stomach; but for the average case and especially for duodenal ulcer where the stomach is usually found to be small, the whole of the cut end of the stomach is implanted into the side of the proximal jejunum. In the Hoffmeister-Finsterer type of gastrectomy, the upper half is closed and on completing the anastomosis to the lower half of the stomach the proximal jejunum is stitched to the closed (upper) part of the stomach, thereby reinforcing the suture line and at the same time interposing a thick valve of gastric and jejunal wall between the outlet of the stomach and the proximal loop.

At the completion of this operation the jejunum will be seen to be almost vertical with the efferent limb, running downward in direct continuation with the mouth of the funnel-shaped stomach (fig. 54).

In the anterior Polya operation a large Payr clamp is applied to the stomach at the line chosen for transection, the pyloric end of the stomach is grasped and pulled upward and slightly toward the

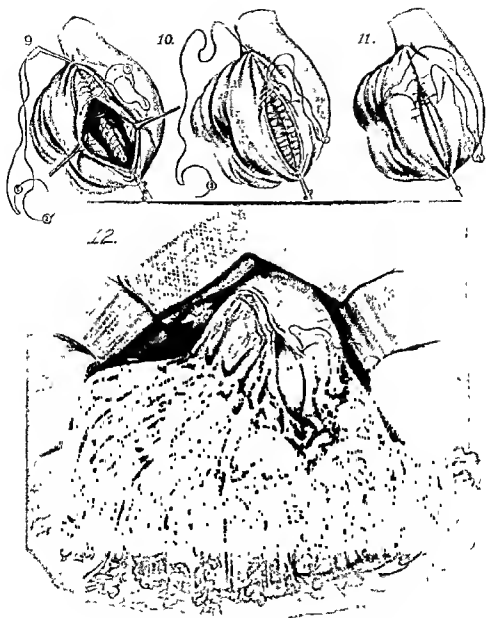


FIG. 52.—PARTIAL GASTRECTOMY FOR CHRONIC DUODENAL ULCER—THE STANDARD OPERATION.

The posterior Polya operation. The three anterior continuous sutures are shown in (9), (10) and (11). In (12) the right margin of the opening in the mesocolon is being sutured to the anterior wall of the stomach just above the anastomotic line. The great omentum, with its blood supply intact, is shown spread out over the transverse colon.



FIG. 53.—PARTIAL GASTRECTOMY FOR CHRONIC DUODENAL ULCER—THE STANDARD OPERATION.

(1) The posterior Polya operation completed. The transverse colon is drawn upwards to show the line of anastomosis.

(2) The anterior Polya operation completed.

(3) Balfour's operation. This method is not advised for cases of chronic duodenal ulcer, but may be indicated in certain cases of sub-total gastrectomy for cancer of the stomach.

left costal margin, and the Allis forceps on the lesser and greater curvatures which are acting as markers or guides are drawn laterally. The anterior and posterior walls of the stomach are flattened together with the fingers, and the Payr clamp is applied. The handle of the clamp is elevated and then everted to the left to bring the posterior surface of the stomach well into view. The proximal jejunal loop is then taken across the transverse colon and applied to the stomach from right to left, *i.e.*, from the lesser curvature to the greater curvature, and the anastomosis is carried out in the manner described for the posterior operation.

In cases where gastrectomy is being performed for duodenal ulcer, enterostomy clamps are not generally used, as they may cause additional damage to the friable gastric mucosa. They are, however, often necessary when the upper half of the stomach has to be closed before performing the anastomosis to the lower half, as in the Finsterer types of operation.

MODIFICATIONS OF THE STANDARD OPERATION

The modifications of the anterior Polya operation include those devised by Moynihan, Balfour and Pauchet.

In the *Moynihan operation* the proximal end of the selected jejunal loop is anastomosed to the greater curvature and the distal end to the lesser curvature. The jejunal loop is short, rarely exceeding 4 to 5 inches, and is brought from the fixed point of the duodeno-jejunal flexure across the colon, as close to the splenic flexure as is possible, and applied to the whole cut end of the stomach from left to right, two rows of continuous sutures being employed in restoring the continuity of the alimentary canal.

This is an excellent method, widely practised, and sponsored by many of the pupils of its famous originator. Pannett, Lalcy and others speak well of the method, but although I have practised it on many occasions I have now abandoned it in the belief that post-prandial discomfort is a common sequel.

The *Balfour operation* is commenced by mobilising the pylorus and the first portion of the duodenum, and after the duodenum has been divided and its distal end securely closed and invaginated, the operation proceeds as in the standard method until a stage is reached

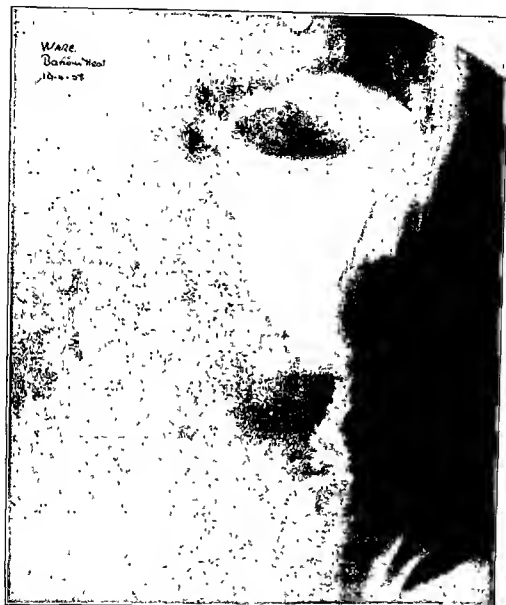


FIG. 54.—X-RAY APPEARANCES OF THE SMALL REMAINING GASTRIC POUCH AND DISTAL COIL OF JEJUNUM FOLLOWING THE HOTTMEISTER-FINSTLER TYPE OF PARTIAL GASTRECTOMY.

The opaque meal will be seen leaving the funnel-shaped stomach and entering the distal jejunum. There is no back-flow of barium into the duodenum. This patient suffered no post-operative discomfort of any kind and his digestion was perfect (Derry).

when the jejunum is ready to be anastomosed to the stomach. Here a long loop of jejunum, some 12 inches or so, is used instead of a short one. Here, too, the loop is taken from the right to the left across the stomach, so that the proximal part of the clamped jejunum lies against the lesser curvature and the distal part against the greater curvature. The anastomosis between the jejunum and stomach proceeds as in the operation for gastro-jejunostomy with the aid of clamps, but the operation is completed by making a small entero-anastomosis with two rows of continuous sutures with a stoma not exceeding 1 inch between the proximal and distal loops of jejunum, at the level of the duodeno-jejunal flexure. This is done in order to prevent the retention of pancreatic juice and bile in the long proximal limb.

Balfour considers that this is an important step in the operation, and one which diminishes the likelihood of any untoward after-symptoms. While he would warmly advocate this procedure in cases of gastric ulcer and gastric cancer, he is careful, however, to avoid it whenever possible in many of his cases of duodenal ulcer owing to the high incidence of subsequent jejunal ulceration. The entero-anastomosis diverts a certain amount of the alkaline duodenal contents from the segment of gut attached to the stomach, and herein lies the danger of this method when performed for duodenal ulceration.

Pauchet's method is only applicable to gastric ulcers which are situated very high up on the lesser curvature where access is most difficult. In this operation the portion of stomach distal to the ulcer is resected, and through the open end of the proximal segment a long wedge-shaped excision of the lesser curvature is performed with scissors. The lesser curvature is then reconstructed with catgut or silk sutures, and an anastomosis made between the cut end of the stomach and the first jejunal coil, either retro- or ante-colic. By this method a fair portion of the stomach can thus be preserved and a radical sub-total gastrectomy obviated.

The modifications of the posterior standard operation have already been mentioned, and include those of Hoffmeister, Finsterer, etc.

Pyloric exclusion combined with partial gastrectomy for irremovable duodenal ulcer has the distinguished patronage of von Eiselsberg, Finsterer and Devine. In this operation a large segment of the body of the stomach is removed, the cut end of the stomach is anas-

tomosed to the proximal jejunum, and the pyloric segment preserved in the belief that by combining an extensive reduction of acid production with a maximum alkali conservation and by preservation of the hæmatopoietic factor, the causes of ulceration are effectively and permanently dealt with and post-operative anæmia is avoided, and, as the ulcer is excluded from the gastric chyme and is constantly saturated with pancreatic juice, healing is assured (figs. 55 and 56). Unfortunately there is a potent factor produced in the antral mucous membrane, a hormone named gastrin, which calls up an after-secretion of acid from a large area of the principal glands of the body of the stomach, and it is this which defeats the aims of an otherwise ideal operation.

Ogilvie (*Lancet*, 2:295, 1938) entirely condemns this method. On analysing his series of cases he found that it produced a significantly high percentage of recurrence of ulcers and was quick to realise that the chemically induced flow of hydrochloric acid, stimulated by an agent arising in the pyloric mucous membrane, was more dangerous than the psychic one; this latter, he says, is poured on to food, the former on to an empty stomach.

This operation in its original form should be avoided at all costs, but, as modified by Bancroft and more recently by Wolfson and Rothenberg (*Surg.* 3:663, 1938) it becomes a simple, safe and excellent procedure for the large fixed penetrating ulcer of the posterior wall of the stomach.

The operation which I now perform with the greatest satisfaction is based upon Wolfson and Rothenberg's technique, and is conducted as follows: An incision is made through the seromuscular coats of the stomach, about 2 inches above the pyloric sphincter, and completely encircles the stomach at this level (fig. 57). The seromuscular layer is picked up with toothed dissecting forceps, and by gauze dissection the mucosa is stripped off the muscular coat as far as the pyloric ring. The dissection is stopped when it reaches the pyloric ring, at which point the mucosa is intimately blended with the underlying muscle. The cuff of pyloric muscle is folded over the pyloric sphincter and the unopened tube which is mucosa is doubly clamped at each end and cut away (fig. 57[2]). The proximally applied clamp is a hinge-covered Payr enterotome (Sklar), as used by Wolfson (fig. 57[3]). The pyloric stump of mucous membrane in the embrace of

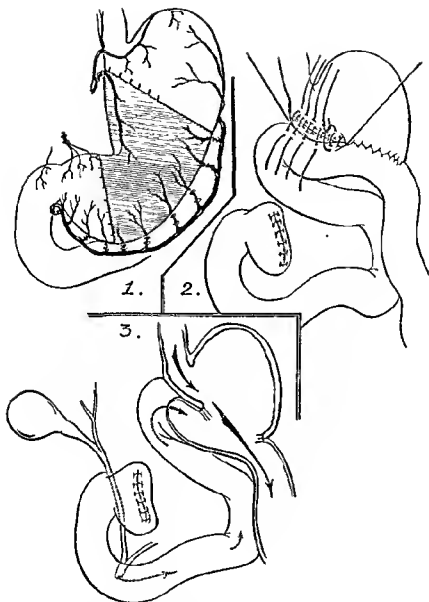


FIG. 55.—PYLORIC EXCLUSION COMBINED WITH PARTIAL GASTRECTOMY FOR IRREMOVABLE DUODENAL ULCER—FINSTERER'S OPERATION.

(1) The shaded area indicates that portion of the stomach which is excised. The pylorus is occluded and the upper half of the cut end of the stomach is closed.

(2) A diagrammatic representation of the operation nearing completion.

(3) Sketch showing the direction of the alkaline juices and food. Note the position of the gastric valve which is said to mitigate the efflux of nourishment into the duodenum.

the distal clamp may be simply ligated or—better still—it may be inverted into the duodenum *through the pyloric ring* by a purse-string suture.



FIG. 56.—FINSTERER'S OPERATION OF PARTIAL GASTRIC EXCISION WITH PYLORIC OCCLUSION FOR IRREMOVABLE DUODENAL ULCER.

The vascular epiploic arch has been freed from the greater curvature, the pylorus divided between clamps, and the invagination of the pyloric stump commenced.

The seromuscular coats of the pylorus are now inverted by a continuous suture, after which they are further invaginated and plugged against the pyloric outlet with interrupted sutures of silk which, on

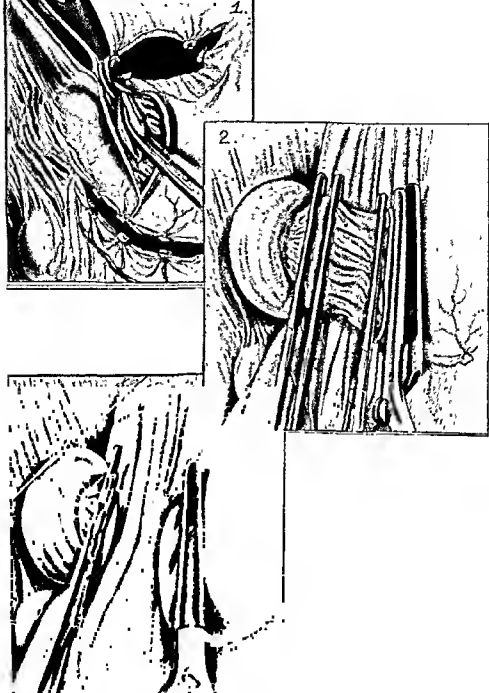


FIG. 57.—PARTIAL GASTRECTOMY FOR IRREDUCIBLE DUODENAL ULCER—WOLFSON AND ROTHFENBERG'S TECHNIQUE.

(1) A circular incision is made through the seromuscular coats of the antrum about 2 inches from the pyloric ring, and the mucous membrane is freed as far as the commencement of the duodenum.

(2) The cuff of pyloric mucous membrane is clamped close to the pyloric ring.

(3) The mucous membrane of the pyloric ring is clamped and ligatured and at a later stage in the operation this is invaginated into the duodenum. Partial gastrectomy is then performed and the gastro-intestinal continuity is restored.

being tied, embrace a fair portion of omentum (fig. 58). The stomach is then resected, and at least two-thirds of it is removed, after which the posterior retro-colic anastomosis is carried out as already described.

When this operation is completed, we have a closed pyloric stump minus its mucosa, an excluded duodenal ulcer left in situ, and a high gastric resection with a jejunal anastomosis.

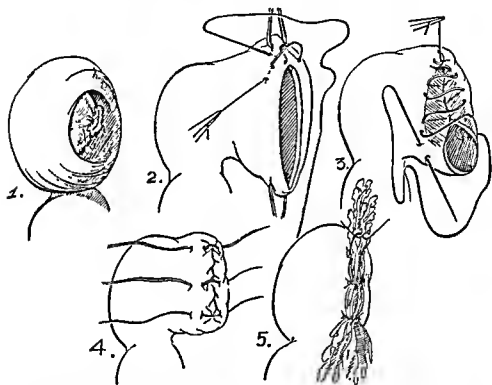


FIG. 58.—PYLORIC EXCLUSION BY THE WOLSON AND ROTHENBERG METHOD.

The seromuscular cuff of pylorus is carefully sutured and invaginated and the suture line is protected with adjacent omentum.

In summing up it may be said that if the first portion of the duodenum with its contained ulcer can be excised with reasonable safety, duodenal occlusion is the method of choice; but if the parts around are so fixed as to preclude removal of this segment of the intestine, then occlusion of the pylorus minus its mucosa may be recommended with every confidence.

MISCELLANEOUS OPERATIONS

1. **Partial Fundusectomy.** This operation was devised by Connell and consists of excising a huge V-shaped wedge from the body of the stomach. At the apex of the V-excision the lesser curvature is left intact, but the middle third or more of the greater curvature and a large triangular portion of the anterior and posterior walls of the stomach are removed in one piece, after which the defect in the gastric wall is repaired at right angles to its longitudinal axis so that no narrowing results. The excision of a portion of gastric wall including a large area of the principal glands aims at bringing about a cure of the ulcer by modifying gastric physiology, particularly the secretory mechanism; but Connell (*Surg., Gynec. & Obst.*, 62:217, 1936) urges that when organic pyloric stenosis is present an additional plastic repair of the pyloric outlet should be undertaken. Without organic pyloric obstruction the ulcer might or might not be removed; but in either event the operation should be followed by the usual post-operative medical management.

Connell considers partial fundusectomy the ideal physiological operation for refractory duodenal ulcer, and assures me that in his hands the results of this operation to date have been encouraging.

2. **Gastric Exclusion.** Devine's operation of gastric exclusion (*Surg., Gynec. & Obst.*, 47:239, 1928) is a simple procedure, as the ulcerated area is ignored, the stomach is obliquely transected in its upper third, the lower cut end of the stomach closed, oversewn and then dropped back, and the proximal cut end anastomosed with the first loop of the jejunum. The major portion of the stomach is therefore excluded, the inert gastric cul de sac tends to atrophy and shrink owing to disuse, food cannot irritate the ulcer, the gastro-enteric stoma, which lies almost transversely, works efficiently, and should anything go wrong subsequently with the parts concerned at the first operation, there is always the dormant gastric pouch at hand which can be utilised at a second operation.

This would appear to be a logical undertaking, but the immediate results following this operation for duodenal ulcer are definitely bad. For irremovable cancer of the pyloric end of the stomach the immediate results are excellent and far exceed those attainable by gastro-jejunostomy, while for the massive perforating peptic ulcer

of the antrum in debilitated subjects, the results are good and greatly simplify resection of the excluded gastric segment containing the ulcer at the second operation owing to the subsidence of surrounding inflammation and to the remarkable degree of healing which occurs in the ulcer itself. It has a place therefore in the treatment of cancer of the stomach and for those rare ulcers of the antrum which demand removal by a two-stage operation. But for duodenal ulcer, this operation stands condemned and should never be practised, as it leaves behind in the pyloric mucous membrane all the agents of evil.

The results of gastric exclusion for duodenal ulcer in five of my patients were most unhappy; but recently I have made amends in one case by re-operating and removing the closed gastric stump together with the first part of the duodenum and its ulcerated surface. This patient, some fourteen months after the operation, remains in good health without any symptoms.

3. **Gastric Devascularisation.** Hey (*Proc. Inter-State Post-Grad. Med. Assembly N. Am.*, 291, 1937) has performed this operation in 100 peptic ulcer patients, but he does not advocate its general adoption as yet, as it has not stood the test of time. "I prefer you to wait for at least another year because time may prove that like so many other operations, devascularisation might find no permanent place in our surgical armament."

In Hey's operation the stomach is freed of all "vascular attachments" except at the cardia and at the pylorus—the stomach is devascularised. As a result the viscus becomes temporarily blue, shrinks, and never fully regains its vascularity. He adds: "I have proved 200 times that complete division of the mesenteries (of the stomach) never causes gangrene in man or dog in the absence of sepsis or arterial disease." In 30 cases of gastric ulcer good temporary results were obtained in 26, while in 58 cases of duodenal ulcer 51 were symptom-free, but in the majority of the latter group gastro-jejunostomy was an added procedure.

4. **Adrenal Denervation.** Crile has performed bilateral denervation of the adrenal glands for chronic peptic ulcer in an attempt to control hyperactivity of gastric function, and the secretory mechanism in particular, with results which are difficult to assess.

CHAPTER 10

GASTRIC ULCER

The proportion of men to women suffering from gastric ulcer was assessed by W. J. Mayo (1915) as being 3:1, and this ratio is identical with the post-mortem figures reported by Robertson and Hargis (1927). The operative figures, however, show a great preponderance of duodenal over gastric ulcer, approximately 10:1.

The immediate and late results of treatment, whether medical or surgical, are far superior in the cases of chronic gastric ulcer to those in the cases of chronic duodenal ulcer. Perforation and massive hæmorrhage are rarer in gastric ulcer, but whereas it may be said that cancerous degeneration of a duodenal ulcer is a pathological curiosity, in gastric ulcer it is a distinct possibility and a menace which cannot be ignored.

PATHOLOGY

Gastric ulcers may be acute, sub-acute or chronic. Approximately 82 per cent of chronic gastric ulcers are found on or near the lesser curvature, between the incisura angularis and the cardiac orifice, the vast majority of these being closer to the incisura than to the cardiac orifice; 12 per cent are found in the antrum, and of these less than 2 per cent are situated in the pyloric canal itself. Whereas 15 per cent of cancers arise in the cardia, less than 1 per cent of gastric ulcers are found in this region. In the rest of the body of the stomach, *i.e.*, the fundus, the anterior and posterior walls of the body, and along the greater curvature, the incidence of simple ulcer is slight, possibly not more than 5 per cent. It is rare to find two or more chronic gastric ulcers in a state of activity at the same time, but combined ulcers, *i.e.*, a gastric ulcer associated with a duodenal ulcer, are encountered in about 10 per cent of cases.

The naked eye appearances of gastric ulcers are similar to those of duodenal ulcers except that ulcers in the stomach are larger, tend

to penetrate more deeply, and are associated with a greater degree of fibrosis. At operation the majority are easy to see and feel. When situated on the lesser curvature, by dividing the transparent middle portion of the gastrohepatic omentum the lesser curvature can be sufficiently mobilised to enable the ulcer to be picked up with the thumb and fingers and carefully examined. There is often considerable local adjacent congestion of the blood vessels, scarring, dimpling and mottling of the gastric wall, and thickening of the adjacent omentum with a few shotty, congested, enlarged lymph glands, while the ulcerated mass feels densely hard. By invaginating the anterior wall of the stomach with the finger, the crater can be identified as a pit or rounded defect. When the ulcer is situated posteriorly it will be necessary to incise the gastro-colic omentum to gain access to the lesser sac, and on drawing the greater curvature upward the angry, inflamed ulcer zone will be readily identified.

Small lesions are easily overlooked, and in order to locate them it is necessary to mobilise the middle third of the stomach, to palpate the whole length of the lesser curvature methodically, to search for inflamed lymph nodes which are always present, and to examine the pyloric region and cardia with scrupulous care.

The surgeon should also bear in mind the possibility of dual lesions in the stomach, and when present that one ulcer may be malignant and the other simple; of combined ulcers; and of accompanying diseases of the gall-bladder or appendix.

Are there any signs discernible at operation which would indicate with tolerable certainty that a supposedly simple ulcer is undergoing malignant change or is, in fact, already a small ulcerating carcinoma? There is none. If the ulcer is large, say, with a diameter of over 2.5 cms., has a somewhat irregular margin and is deeply pitting the pancreas or liver, surely such a combination would prejudice the surgeon in favour of malignancy (fig. 59). Yes, but many simple ulcers also have the same characteristics. Most operations for gastric ulcer are undertaken when it has been impossible by clinical, laboratory, radiological, gastroscopic and medical methods to rule out the possibility of malignancy. Chronic ulcerating gastric lesions should be assumed to be cancerous until they are proved beyond cavil to be benign. If the therapeutic test has been carefully applied and healing of the ulcer does not occur in a specified time, then operation should



FIG. 59.—SKIAGRAM OF A LARGE GASTRIC ULCER.

Partial gastrectomy was performed by the anterior Polya method. Section of the margin of the ulcer showed malignant degeneration on microscopical examination (Derry).

be undertaken; but it is impossible at operation to be sure whether we are dealing with a simple or a malignant ulcer, and the only safe rule is to regard all gastric ulcers as malignant and to perform a radical excision. Even when the surgeon has the resected portion in his hands and is able to examine it at leisure, he is often still unable to state conclusively whether the ulcer is innocent or malignant. The microscope then becomes the last court of appeal. Many sections should be made through adjacent stomach wall, through the margins and the base, and serial sections should be taken at every conceivable angle through the ulcer and examined by experienced and unbiased pathologists.

Whether the wider use of the flexible gastroscope will prove of great value in this difficult matter of distinguishing simple from malignant ulcers, I do not know. When I think of the number of cases I have seen in which the innocent naked eye appearance of the specimen after resection has been falsified by the microscopic evidence of malignancy, I am doubtful.¹

SIGNS AND SYMPTOMS

In approximately 50 per cent of cases of gastric ulcer the symptoms, the physical signs and the analysis of the gastric content are identical with those found in non-stenosing duodenal ulcer. As in duodenal ulcer, the most important symptoms are pain, vomiting and hæmatemesis. The pain at first is insidious and slight, amounting to little more than a sensation of discomfort and fullness in the epigastrium; but in a well-established case it becomes severe in character and arises shortly after the intake of food. The situation of the ulcer and the onset of certain complications will cause marked variations in the nature of the symptoms. For instance, when an ulcer is situated high on the lesser curvature near the cardia, pain will be experienced during meals or shortly afterward, while when the pyloric segment is involved, pain may not arise for two or three hours after the ingestion of food. Pyloric ulcers mimic duodenal ulcers in that the onset of pain is delayed and food affords almost instant relief. On the other hand, they cause great impairment of gastric motility and marked spasm of the pylorus, leading to occasional attacks of vomiting, nausea and flatulence, with considerable visceral disturb-

¹ Morley, *Brit. M. J.*, 1:314, 1937.

ances which demand immediate attention, early investigation and possibly operation.

Ulcers of the middle third of the lesser curvature produce symptoms which in some ways resemble those of duodenal ulcer, but the pain arises $\frac{1}{2}$ to 1 hour after meals and slowly disappears before the next meal. Food and alkalis, however, do not alleviate the pain so completely as they do in duodenal ulcer, but belching and vomiting afford instantaneous appeasement. Small feedings may give relief, but large feedings often cause distress. Patients learn that by taking tablets of malted milk and the like shortly before the pain is due, they can almost certainly forestall its onset or mitigate its severity.

Patients with gastric ulcer rarely, if ever, experience pain during the night, and seldom on an empty stomach in the morning before breakfast. The attacks of pain last a variable time—an hour or two, sometimes less, sometimes more, and when complications ensue the pain may be continuous and exhausting. The pain radiates to the back or to the left shoulder when the ulcer has penetrated to the capsule of the pancreas, to the liver or to the diaphragm. Backache is therefore a symptom of the greatest importance, denoting anchorage.

In a typical case the patient will give a history of recurrent attacks of dyspeptic pain, each lasting for a few days, weeks, or possibly months, with intervals of freedom for a variable period; but as the disease progresses these remissions become shorter and shorter, pain becomes more intense and incoercible, and the well-tried anodynes are no longer dependable. Vomiting is now more troublesome, and is frequently self-induced. In cases of gastric ulcer appetite and nutrition are usually good except where the disease has been of long standing, in which case owing to the fear of the pain that will follow the intake of food enforced abstinence often results in loss of weight and a severe degree of malnutrition. With the onset of pyloric obstruction, of hour-glass stomach, of cancerous transformation or of deep penetration of the ulcer, loss of weight may be very marked and the symptom-complex become irregular, suggesting at times that a primary cancer in the stomach is rapidly advancing.

On physical examination there is often a point of maximum tenderness to be found in the epigastrium, close to the costal margin on the left side or in the midline below the xiphisternum. Guarding will

be marked at the height of the ulcerative activity, but this will be absent when the ulcer is quiescent. There is, as yet, no symptom or sign or any combination of symptoms and signs which will determine with certainty whether a circumscribed ulcer in the stomach is malignant or benign.

DIAGNOSIS

With our present methods of diagnosis, and these include history of the case, physical examination of the patient, analysis of the gastric contents, complete examination of the blood, occult blood tests, X-ray investigations, and gastroscopic enquiry, it is not difficult to arrive at a diagnosis of simple ulcer or ulcerating carcinoma; but to distinguish these two conditions and to divide cases into two groups is supremely difficult and presents a most important problem.

Rivers and Dry, of the Mayo Clinic, have suggested that a patient who has a gastric ulcer should be suspected of harbouring malignancy if:

1. He is over 60 years of age and gives a short history of indigestion.
2. The symptoms are of short duration and have persisted without remission.
3. There is no relief of symptoms following careful medical treatment, and in addition to this the ulcer crater has not diminished appreciably in size after three weeks' probationary supervision.
4. Occult blood continues to appear in the stools.
5. The ulcer is situated in the pyloric region or at or near the greater curvature.
6. Gastric analysis shows absence of free hydrochloric acid or low acid values of the gastric juice.

On the other hand, the following criteria would suggest that the lesion is benign if:

1. The patient is young.
2. There are long periods during which the ulcer is quiescent.
3. Gastric acidity is persistently high.
4. Hour-glass deformity is present.
5. Symptoms completely disappear under medical treatment, bleeding ceases, pain abates, and the fluoroscope reveals that the breach in the stomach has healed over.

In the differential diagnosis between simple ulcer and ulcer-cancer, the greatest importance is attached to the therapeutic test (page 301), although I must emphasise that no pre-operative tests or the application of any criteria such as have been enumerated above can be deemed entirely trustworthy. It is significant that some patients with ulcerating cancers temporarily gain weight, lose all their symptoms and appear to be progressing most satisfactorily, and, what is often more misleading, a definite crater or filling defect may disappear at fluoroscopic examination after a course of medical treatment, giving rise to the erroneous impression that a permanent cure has been effected. The results, I need hardly add, in such cases are often disastrous.

Pyloric ulcer, by producing obstruction leading to a deformity of the outlet of the stomach, may be mistaken for a duodenal ulcer, while the rare syphilitic or tuberculous ulcer of the stomach may cause trouble in arriving at a differential diagnosis.

TREATMENT OF GASTRIC ULCER

Indications for operation are:

1. Acute perforation.
2. Organic hour-glass deformity.
3. Organic stenosis due to a chronic pyloric ulcer.
4. Recurrent massive hæmorrhage.
5. Doubt as to the benignity of the lesion after a course of medical treatment.
6. Ulcers situated on the greater curvature or in the pyloric region, since malignancy cannot here be ruled out.
7. Multiple gastric ulcers or combined chronic gastric and duodenal ulcer.
8. Large ulcer which has penetrated deeply into the substance of the pancreas or liver.
9. Failure of efficient medical measures to bring about healing of the ulcer.
10. Patients over 60 years of age who give a short history of indigestion.
11. Gastric ulcer associated with gall-stones or chronic appendicitis.

12. Expedient circumstances and economic reasons in certain cases.

With the exception of acute perforation, few patients with chronic gastric ulcer are in need of immediate surgical measures. Medical treatment is eminently satisfactory, as is shown by Eusterman, who obtained cures in 75 per cent of the cases referred to him. Most physicians claim a high percentage of cures, but the prolongation of medical treatment is not justifiable if a chronic gastric ulcer cannot be induced to heal within six weeks, and in such cases surgery should be invoked unless there are very strong indications to the contrary.

The Management of Patients with Chronic Gastric Ulcer. Every patient is subjected to the same routine methods of investigation as already outlined, and after the presence of an ulcer in the stomach has been demonstrated by means of X-rays the physician and surgeon should meet in consultation and decide what lines the treatment should take. The following factors will influence the choice of treatment:

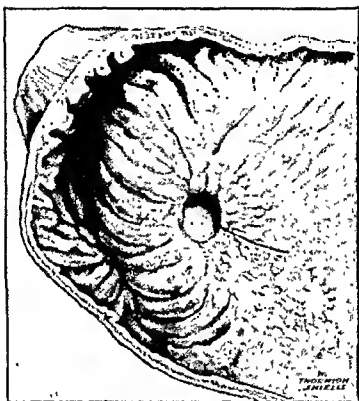
1. *The Age of the Patient.*

We have so far failed to find a benign gastric ulcer which has not been accompanied by clinical evidence of its presence before 60 years of age; in other words, we believe that all gastric ulcers which make their appearance after 60 years of age are malignant and the patient should be advised to have a gastric resection as soon as adequate pre-operative preparation permits.²

2. *The Position of the Ulcer.* Holmes and Hampton (*J. Am. M. Ass.*, 99:905, 1932) have stressed the fact that some 90 per cent of ulcers proximal to the pyloric canal but within about 1 inch of it are malignant. Finsterer (*Rev. de chir.*, 72:511, 1934) has also urged that such pre-pyloric ulcers should receive surgical attention as soon as they are diagnosed in view of the fact that they are so often cancerous (figs. 60 and 61).

Peptic ulcers involving the greater curvature of the stomach outside the immediate vicinity of the pylorus are very uncommon. David (*Acta. chir. Scandin.*, 64:329, 1928) reviewed the literature appearing after 1914 and found 16 true peptic ulcers of the greater curvature. The most authoritative paper dealing with this subject is

² Roscoe Graham.



CHRONIC GASTRIC ULCER

Gastrectomy specimen. Section from one margin of the ulcer showed no evidence of malignancy.

by Matthews, who described two personal cases and analysed 139 which had been published up to 1935. He writes:

Ulcers of the greater curvature produce no characteristic symptoms distinguishing them from other peptic ulcers. There is no certain method of determining whether a lesion found on the greater curvature is benign or malignant, except by histological examination. A review of the cases described illustrates how difficult it may be to differentiate this type of peptic ulcer from carcinoma.²



FIG. 60.—PYLORIC PEPTIC ULCER (BULL).

I performed a partial gastrectomy on a male patient of 65 years of age who had a chronic ulcer on the greater curvature of the stomach $2\frac{1}{2}$ inches distant from the pyloric ring (figs. 62 and 63). At operation the crater was embedded in the mesocolon, a portion of which had to be excised in order to mobilise the stomach. The ulcer was large enough to admit the tip of the index finger, and to the naked eye it appeared to be malignant, but on microscopical examination

² Matthews, *Ann. Surg.*, 101:811, 1935. Courtesy of J. B. Lippincott Co

fortunately it proved to be benign. This patient made a good recovery following partial gastrectomy.

3. *The Presence of Multiple Chronic Ulcers in the Stomach as well as the Combination of Gastric Ulcer plus Duodenal Ulcer.* It is generally agreed that such combined lesions, when found, are sufficient to warrant surgical measures. I once performed gastric excision upon a patient who had two chronic ulcers in the stomach, one being



FIG. 61.—PYLORIC PEPTIC ULCER (BULL).

situated on the lesser curvature about the incisura, and the other directly opposite it on the greater curvature. The lesser curve ulcer was innocent, but on the greater curve was an ulcerating carcinoma.

4. *The Size of the Ulcer.* Scott and Mider write:

It was hoped at one time that the size of the ulcer as revealed roentgenologically might be a good index of its character. It is true that the majority of ulcers over 2.5 cms. in diameter are malignant, while most of the smaller ulcers (1 to 1.5 cms.) in diameter prove to be benign. However, there are so many exceptions to this general rule that it is almost valueless as a guide to therapy in the individual case.⁴

It may be said that when a patient has a large ulcer which has penetrated all the coats of the stomach and has attached itself to the

⁴Scott and Mider, *Am. J. Surg.*, 40-42, 1938.

underlying pancreas or liver—chronic perforation—it is unlikely that medical measures will be of any avail, and the menace of malignancy is a very real one (figs. 64, 65 and 66).



FIG. 62.—LARGE GASTRIC ULCER SITUATED ON THE GREATER CURVATURE OF THE STOMACH, $2\frac{1}{2}$ INCHES DISTANT FROM THE PYLORIC RING.

Partial gastrectomy performed. The ulcer showed no evidence of malignant change (Post).

5. *Hour-Glass Deformity.* It is exceptional to find malignant change associated with hour-glass deformity of the stomach due to

peptic ulceration (fig. 67). It is conceivable that medical treatment or, rather, stringent dietetic measures may keep the patient in a moderate state of nutrition when the ulcer, on healing, has left a small but adequate channel for food. But such patients are chronic invalids, and sooner or later operative measures will be necessary to overcome the effects of obstruction. I would regard hour-glass



FIG. 63.—CHRONIC GASTRIC ULCER ON THE GREATER CURVATURE—BERG-TECHNIQUE (POST).

deformity as a definite indication for operative interference at any age, and I have successfully performed partial gastrectomy under local anæsthetic upon patients who were aged 75, 78 and 81, respectively.

6. *Response to Medical Treatment.* It should be remembered that complete disappearance of symptoms with a gain in weight when

the patient is subjected to medical treatment is no evidence whatsoever that the ulcer is benign in character; in fact, a cancerous gastric lesion will frequently respond in this manner when it presents irrefutable X-ray evidence of its malignancy.

Medical treatment should be persevered with when it has afforded prompt relief of symptoms, when blood disappears from the stools,



FIG. 64.—SKIAGRAM OF THE CRATER OF A LARGE GASTRIC ULCER.

Partial gastrectomy performed. On microscopical examination a small patch of carcinomatous infiltration was detected (White Phillips).

and when skiagrams show that there is a progressive decrease in the size of the ulcer crater. But frequent periodical examinations are necessary to show that healing, once established, remains permanent. A return of symptoms while the patient is undergoing medical treatment or failure of the ulcer to decrease appreciably in size immediately suggests to the examiner that the lesion is in all probability a carcinoma.

The chief indication therefore for operation is the failure of medical treatment, and this must always remain the principal indication

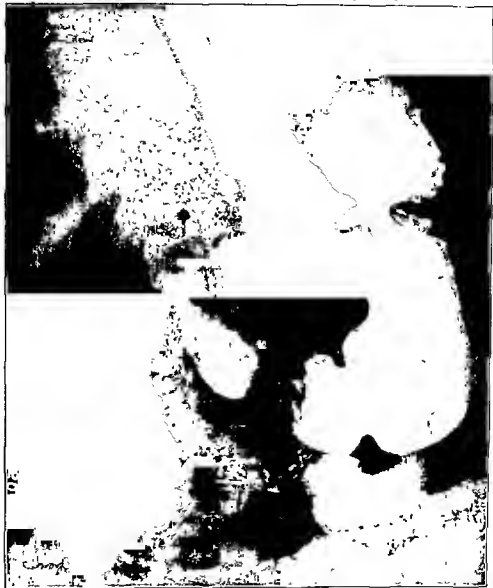


FIG. 65.—SKIAGRAM OF LARGE CHRONIC PENETRATING GASTRIC ULCER.

Partial gastrectomy performed. The ulcer, which was with difficulty detached from the pancreas to which it was adherent, showed no evidence of malignant degeneration (Graham Hodgson).

in cases both of chronic gastric and of chronic duodenal ulcer. It stands to reason that the cases which are eventually subjected to sur-

gical measures are those which are suspected of having cancer, those with large fixed penetrating lesions, those with gross anatomical deformity of the stomach—the result of scarring, those whose lives are threatened by hæmorrhage, and those who are distracted to breaking point by intractable racking pain. They all constitute poor surgical risks, but alternatively they have to face a life of chronic invalidism, early death, or an extensive radical operation with all that it offers,



FIG. 66.—THE CRATER OF A LARGE CHRONIC GASTRIC ULCER.

The partial gastrectomy specimen showed no evidence of cancer. Following the therapeutic test there was no appreciable diminution in the size of the ulcer and occult blood was present in the stools (Bull).

i.e., either speedy demise or else a rapid return to robust health with a hearty appetite and restored economic efficiency. The commonest cause of death in those who survive the stern ordeal of this severe operation is cancer of the stomach, which may occur months or even years later. This should be a timely reminder that when we do operate for ulcer of the stomach we should operate as for cancer. Our operation should therefore not only give the assurance of relief of symptoms and protection against recurrence of ulceration, but it

There are, of course, many well-known schemes of conducting a satisfactory course of medical treatment, but I have been so favourably impressed by Einhorn's method (*Med. Rec.*, 96:95, 1919) of duodenal feeding by an indwelling tube that I would consider it to be the procedure of choice in the management of lesser curve ulcers. The aim is to place the stomach at rest by preventing food from entering it during the course of treatment. But there are no means of arresting the continuous secretion of gastric juices which, however, may be diminished or in part neutralised by giving the patient frequent drinks of alkaline fluids containing adequate doses of belladonna. An Einhorn or Ryle tube is used, this being swallowed and proved by fluoroscopy to be lying in the duodenum. When the tube is in position, the end is clipped and attached to the side of the cheek with a small strip of adhesive tape. Most patients tolerate the presence of the tube very well, and in some instances it may be left in situ for as long as three to six weeks without being disturbed. Through the tube 6 to 8 oz. of peptonised milk, cream, malted foods, milk and fruit juices are injected with a large glass syringe every two hours. After each feed the tube is washed through with normal saline to prevent it from becoming clogged, the mouth also, of course, receiving special attention. Alternatively to this method of duodenal feeding by the indwelling tube, milk may be given by the continuous drip method, the flow being regulated so that the patient receives from 5 to 8 pints in the twenty-four hours, according to individual requirements.

At the end of three weeks' treatment the stools are examined for occult blood, and X-ray pictures are taken of the stomach. If the symptoms are subsiding and the ulcer niche is smaller, a further trial of three weeks' treatment is ordered. If the ulcer has not healed at the end of six weeks, operation is advised. If, on the other hand, the ulcer has healed, further skiagrams should be taken after an interval of another three weeks. If healing appears to be sound and satisfactory, the patient is then ordered Hurst's post-ulcer regime of diet.

If at the end of the first three weeks there is no appreciable relief of symptoms, and skiagrams do not reveal any marked diminution in the size of the crater, operation is recommended on the assumption that the ulcer is malignant. Again, should there be a recrudescence of pain and radiological support that the ulcer is active once

more after a period of quiescence, then operative measures will be required.

Duodenal feeding yields good results, especially for the uncomplicated lesser curve ulcer, and may be successful even for the large excavating lesion which is so often seen near the cardia and for which gastro-jejunostomy or jejunostomy alone is so frequently invoked. Einhorn recorded cures in nearly 90 per cent of 315 patients treated by this method, while excellent results have also been claimed by Young, Mortimer Woolf and Cleaver. No one knows what percentage of chronic gastric ulcers undergoes malignant transformation. It may be as low as 5 per cent or as high as 50 per cent; but we do know that the ever-present fear that an ulcer in the stomach may be an ulcer-cancer dominates in the mind of the surgeon the whole aspect of treatment.

OPERATIONS FOR CHRONIC GASTRIC ULCER

1. Excision alone.
2. Gastro-jejunostomy alone (von Hacker).
3. Wedge excision combined with gastro-jejunostomy (Walton).
4. Cautery excision combined with gastro-jejunostomy (Balfour).
5. Segmental or sleeve resection (Reidel-Rodman).
6. Excision of pyloric (gastric) ulcer combined with pyloroplasty (Judd).
7. Partial gastric occlusion (Devine).
8. Partial gastrectomy: (a) Billroth I types; (b) Billroth II types—*anterior and posterior Polya*.
9. Cholecysto-gastrostomy (Braithwaite).
10. Jejunostomy.

The objects of any gastric operation for peptic ulcer are:

(1) Removal of the lesion; (2) permanent alteration of the motor and secretory function of the stomach; (3) assurance of relief from symptoms; (4) protection against recurrence of ulceration and of the subsequent development of cancer of the stomach.

The success or failure of the operative treatment for gastric ulcer depends to a great extent upon the following: (1) The selection and preparation of the patient for operation; (2) the selection of the operation for the individual case; (3) the skill of the surgeon and

the technique employed; (4) the methods adopted in conduction of the after-care; (5) unexpected complications.

There is as yet no routine operative procedure for gastric ulcer. An operation which may be considered advisable in one case may be unnecessarily dangerous and totally inadequate in another. The best results follow those measures directed to a wide excision of the lesion, the overcoming of stasis, and the reduction of gastric acidity. This is achieved in a variety of ways, by far the best being some type of partial gastrectomy in which gastro-intestinal continuity is established by the Polya methods of anastomosis or one of the Billroth I types of repair.

With an increasing experience of the indications, the contra-indications, the difficulties, the technical methods of overcoming certain dangers, and the factors which make for safety, I find that the operation of choice—partial gastrectomy—is applicable in over 80 per cent of my cases. If the ulcer can be removed intact together with the excised portion of the stomach, so much the better; but if this cannot be accomplished, then the stomach, after being mobilised, should be resected and the ulcer crater which has been left behind in the liver or pancreas should be destroyed by heat.

It is generally claimed that excision or destruction of the ulcer by cautery combined with gastro-jejunostomy has a lower mortality and yields results almost as good as those of partial gastrectomy. It should be remembered, however, that this procedure is only applicable to the relatively small free ulcers on the lesser curvature, in fact, the type that is eminently suitable for medical treatment, and that when partial gastrectomy is performed for such cases the death-rate is only slightly higher but the final results are indisputably superior. If partial gastrectomy is reserved only for the complicating, large, fixed penetrating ulcers, it stands to reason that it will be associated with a greater mortality than gastro-jejunostomy plus excision of the ulcer, as the latter operation is only undertaken when the local conditions are extremely favourable.

Excision Alone. It would be indeed an easy solution to the ulcer problem if simple excision could be depended upon to cure every case; but unfortunately this operation is followed by a recurrence of ulceration or by severe crippling symptoms in a high percentage of cases, as is shown by the British Medical Association Report (1930)

which states that excision alone is followed by 50 per cent of failures. Hurst and Stewart report a recurrence in 6 out of 9 of Sherren's cases, 4 failures out of 10 of Dobson's cases, and 15 failures out of 39 in Collinson's series.

Simple excision is an unsatisfactory operation as the motor functions of the stomach are often thereby impaired, and apart from removing a possible source of malignancy and safeguarding the patient against perforation, conditions in the stomach are not materially improved, acidity is not diminished, stasis due to pylorospasm is not overcome, and the newly-sutured line, although tidier than the previous ulcerated area, is buttressed and longer and is prone to suppurate, leading to the formation of a new ulcer at this site. Balfour, however, considers that in exceptional circumstances simple excision may be indicated. He would reserve this operation for those rare cases in which the patient is obese or debilitated, the stomach high lying, the ulcer situated in the anterior or posterior wall of the stomach and not encroaching upon the pyloric segment or the greater or lesser curvature, and where during the process of excision all the scar tissue can be successfully excised. He maintains that if simple excision can be performed without interfering with the normal peristalsis of the stomach, this operation has a field of usefulness.

When contemplating this operation the surgeon should bear in mind that ulcers situated on the anterior or posterior wall of the body of the stomach some distance away from the curvature are often, as Judd reminds us, malignant in character, that a healthy rim of gastric wall should be excised together with the ulcer, thereby leaving a large defect to be sutured transversely in order to avoid constricting the viscus, and that when the ulcer is situated in a posterior position it is often welded to the pancreas, necessitating extensive mobilisation of the greater curvature and a difficult dissection to free the ulcer from its attachments—a task requiring considerable skill, and finally that the after-results are often disappointing and far inferior to those obtained by gastro-jejunostomy alone.

When the ulcer is situated on the anterior wall and excision is deemed advisable, the operative field should be carefully packed off with mackintosh squares and the stomach picked up with Allis forceps to draw it through the wound. The ulcer together with a margin of

healthy tissue is excised with a diathermy needle, any brisk bleeding points are *underrun* and tied, and the gastric contents are aspirated with a siphon. The defect in the gastric wall is closed with three layers of sutures, the first being a continuous suture of No. 0 twenty-day catgut which unites the margins of the mucous membrane; the second suture likewise approximates the seromuscular margins, and when this is completed, the suture line is invaginated with a series of closely applied interrupted Lembert sutures of fine silk.

When a posterior ulcer is to be excised, it is necessary to free the omentum from the greater curvature to gain access into the lesser sac so that a good view of the ulcer can be obtained. After dividing the neighbouring adhesions, the ulcer is detached from the underlying pancreas, and the hard rim of the ulcerated zone left behind on the stomach wall is removed with a fair margin of healthy stomach. This opening is closed as in the anterior operation, after which the crater left behind in the pancreas is destroyed with an electric cautery and the omentum is drawn over it to prevent the stomach from becoming adherent in this region.

Gastro-Jejunostomy Alone. Gastro-jejunostomy may on rare occasions be undertaken when the patient has a large penetrating lesion situated high up on the posterior wall of the stomach close to the cardia, associated with a severe degree of surrounding inflammation and extensive resection is impossible owing to the local condition and the poor state of the patient's health. Here the surgeon would be well advised either to treat the case medically, the patient being fed by the milk drip method, using an Einhorn indwelling duodenal tube, on the lines already laid down, or else resort to the simplest of all indirect operations—*jejunostomy*.

If the stomach tube cannot be passed beyond the ulcerated zone, if, although successfully introduced, its presence cannot be tolerated, or if the patient refuses to undergo treatment by these means and is making no progress on a strict medical regime, operation should be advised.

The greater the experience of the surgeon, the fewer indirect operations will he perform for gastric ulcer. Ulcers which on first inspection appear to be fixed and which are situated high on the lesser curvature or on the posterior wall close to the cardia in a small contracted stomach can often be excised after the viscus has

been thoroughly mobilised and the lesion separated from its attachments posteriorly. In this process of mobilisation the ulcer base is often left behind embedded in the liver or pancreas, and it should in such circumstances be destroyed by heat because of the possibility of malignant degeneration occurring in the margins of the crater. In expert hands the great majority of gastric ulcers can be treated by radical excision and the operation completed by the Polya methods of anastomosis. When circumstances are such that gastro-jejunostomy appears to be the best procedure, the surgeon will often find to his disappointment that the retro-colic route is denied him owing to obliteration of the lesser sac with inflammatory adhesions and to a state of firm cohesion which exists between the posterior surface of the stomach and its bed. When such a state of affairs exists, anterior gastro-jejunostomy supplemented by entero-anastomosis between the proximal distal and jejunal limbs will be the procedure of choice. It is generally known that stomal ulceration following gastro-jejunostomy for gastric ulcer is exceedingly rare, and though on theoretical grounds there may be certain objections to entero-anastomosis, the common experience has been that it does not add to the likelihood of secondary ulcer when carried out for a simple lesion of the stomach.

Balfour has shown that gastro-jejunostomy alone for a chronic gastric ulcer carries a lower risk than any procedure which includes removal of the type of lesion for which this operation is indicated. In one series of cases, gastro-jejunostomy was performed in 228 cases with only 4 deaths, a mortality of 0.7 per cent. This surgeon has pointed out that, in the various series of cases in which the operation has been performed at the Mayo Clinic, the death-rate of gastro-jejunostomy has consistently been about one-fifth that of partial gastro-duodenal resection. He therefore states that

This safety must not mislead the surgeon to disregard the added advantage of removal of the lesion whenever possible, for there are several factors of greater importance than the immediate mortality following gastro-enterostomy alone for gastric ulcer, particularly in regard to malignant degeneration.^a

The operation will bring about a cure in some 50 per cent of cases, and for the type of case for which it is undertaken it would

^a Balfour, *Surg., Gynec. & Obst.*, 21:731, 1917.

appear that it is well worth doing since huge adherent ulcers sometimes heal and remain healed. As convalescence is very slow, prolonged medical treatment and strict dieting are necessary, and the patient will always have to be careful about his food and restricted in his activities.

Wedge Excision Combined with Gastro-Jejunostomy. Walton recommends that all small ulcers in the middle of the lesser curvature of the stomach which are manifestly benign in character should be treated by this method. After the ulcer has been excised, the opening in the stomach is sutured, the pylorus temporarily occluded with a running silk suture, and a gastro-jejunosomy performed, the stoma being placed parallel to the greater curvature and so arranged that one half lies proximal and one half distal to the line of suture of the wound of excision.

In Walton's series (*Prognosis*, 1:109, 1935) of 310 patients, there were 13 deaths, a mortality of 4.2 per cent, and in a group, the members of which were observed for a period of five years or more, there was a complete cure in 88 per cent of cases. Of the total, six patients (in two of whom the excision was by cautery) developed recurrent ulcers, and five patients showed the later onset of carcinoma.

I agree with Joll who writes:

The wedge-excision combined with gastro-jejunosomy operation is a development of the excision operation which permits of the extirpation of larger ulcers especially those involving the lesser curvature. The method has a lower mortality than has partial gastrectomy even though it is technically often more difficult to carry out, but it must not be forgotten that it cannot be applied to the largest fixed ulcers. Recurrence of ulceration is more likely to supervene after the operation and I recently had to operate on a case of this type, nine years after the first intervention, in which a gastro-jejuno-colic fistula had developed in spite of the healthy appearance at the site of the original extirpation. It is claimed for this method that it gives about 90% of satisfactory end-results, a figure approximately equal to that for partial gastrectomy with the retro-colic jejunal loop. It is right to point out that these two operations are not necessarily feasible alternatives, though there are, nevertheless, many cases which can be treated in either way. I do not think that there is anything to choose between the mortality of gastrectomy applied to cases which could equally well have been dealt with by wedge-excision and gastro-jejunosomy, since one is necessarily dealing with ulcers of moderate size which are fairly easily mobilized and which are not very near the cardia. My personal experi-

ence of the operation amounts to only 84 cases but I employ it less and less and prefer gastrectomy....

The mortality of partial gastrectomy is appreciably higher than that associated with short-circuiting methods, but if consideration be given to the added safeguard which it affords against malignant disease developing at or near the site of the ulcer, it is probably true that in the long run there is little to choose between the methods so far as mortality is concerned. Partial gastrectomy is preferable to short-circuiting operations in the freedom which it affords from recurrent ulceration, hæmorrhage and perforation, and also in the greater proportion of cases which are permanently relieved of all symptoms.[†]

The wedge excision of a gastric ulcer may be performed with or without the aid of intestinal clamps. I prefer to carry out the operation without clamps and conduct it as follows: The lesser curvature is mobilised by dividing the middle portion of the gastrohepatic omentum and by ligating and dividing the arteries about 1 inch or so on either side of the ulcerated area (fig. 68). Two pairs of Allis forceps are then placed on the posterior wall and two pairs on the anterior wall of the stomach so as to pick up a quadrilateral portion of the viscus in the centre of which the ulcer is situated (fig. 69). The diamond-shaped area which is to be excised is first demarcated by cutting through seromuscular layers with a knife, after which the stomach is opened and its contents evacuated by means of a suction tube. The index finger is then introduced into the stomach to palpate the crater and to estimate the amount of surrounding scarring and inflammatory thickening, and the ulcer is excised together with a healthy margin of the gastric wall.

As a large defect remains after the lesion has been cut away, it is better to start the suturing of the opening before the wedge is entirely removed (fig. 69 [4]). The suturing of the defect then proceeds simultaneously with the excision. A suture of No. 0 twenty-day chromic catgut mounted on a straight atraumatic needle is used to approximate the margins of the stomach, and when it reaches the top end, *i.e.*, the posterior wall, it pierces all the coats at the apex of the incision and returns as a continuous Lembert suture which invaginates the opposing seromuscular coats (fig. 70 [5 and 6]). When this suture arrives at the point where it started on the anterior wall, it is knotted and cut short.

[†] Joll, *Post Grad. Med. J.*, 12:261, 1936.

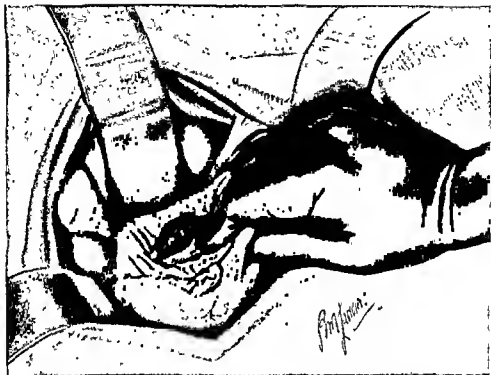


FIG. 68.—EXCISION OF GASTRIC ULCER COMBINED WITH GASTRO-JEJUNOSTOMY

The lesser curvature is mobilised by dividing the gastro-hepatic omentum, and the ulcer together with a portion of the lesser curvature of the stomach is drawn through the wound.

The suture line is now reinforced and further inverted with a series of interrupted mattress sutures of silk, after which the oval gap in the omentum above the lesser curvature is closed and the operation is completed by temporarily occluding the pylorus with a Mayo-Kelling stitch, and a posterior transverse gastro-jejunostomy is performed with the stoma as close to the greater curvature as possible (fig. 70 [9]).

Walton performs this operation with the aid of intestinal clamps. By his method the stomach is drawn well up into the wound and the gastrohepatic omentum is opened above the ulcer so that the posterior aspect of the stomach can be thoroughly explored. If any adhesions are found here they are separated to permit of a free mobilisation of the organ, the right and left gastric arteries being divided proximal and distal to the site of ulceration.

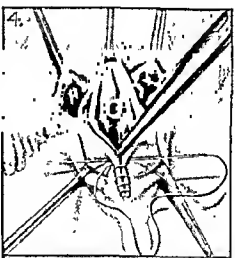
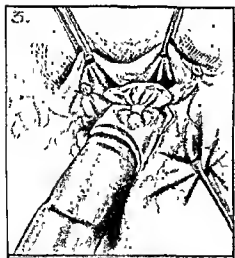
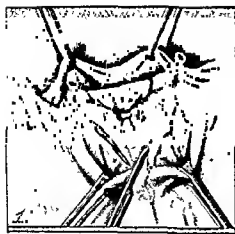


FIG. 69.—EXCISION OF CHRONIC GASTRIC ULCER COMBINED WITH GASTRO-JEJUNOSTOMY.

(1) Diamond-shaped area of stomach wall which includes the ulcer is demarcated.

(2) The stomach has been opened and a suction tube removes all gastric contents.

(3) The index finger is inserted through the gastric opening to palpate the ulcer and surrounding area of thickening.

(4) The ulcer together with a healthy margin of stomach wall is being excised, and suturing of the defect is commenced.

An opening is then made in the gastro-colic omentum and one blade of an enterostomy clamp is made to pass below the stomach and to emerge on the lesser curvature about 2 inches above and to the cardiac side of the ulcer. The other blade is passed anterior to the stomach, after which the two blades are clamped. A second opening is made through the gastro-colic omentum near the pyloric region, and a second clamp is applied in a similar manner to the first, again about 2 inches from the ulcer but below and to the pyloric side so that the ulcer lies between the tips of the two clamps. Thus the clamps isolate the ulcer together with a cylindrical portion of the stomach, in this way preventing contamination and facilitating approximation of the parts after excision of the ulcer. By controlling hæmorrhage they render suturing of the resulting gap a relatively easy matter. A large, hot, moist square is then packed into the lesser sac and covered with a mackintosh sheet. A wedge-shaped portion of the lesser curvature including a generous rim of healthy tissue together with the ulcer is removed with scissors or an electric cautery, and the clamps are slightly rotated to bring the posterior lips of the wound into apposition. The heart-shaped defect in the stomach is then closed with two rows of continuous sutures and reinforced with a few interrupted seromuscular sutures of fine silk. After this the operation is completed by performing a transverse gastro-jejunostomy near to the greater curvature, and the pylorus is temporarily occluded.

Cautery Excision or Destruction of the Ulcer Combined with Gastro-Jejunostomy. Balfour's operation (*Surg. Clin. N. Am.*, 1:5, 1921) is reserved for those cases in which a small ulcer is found in the region of the lesser curvature near the cardia on the posterior wall in a rather inaccessible position where V-excision may prove difficult to perform or where partial gastrectomy for one reason or another may be contra-indicated. In such cases the destruction of the ulcer by the cautery is a simpler, safer and quicker method than wedge-excision.

The portion of the stomach in which the ulcer is situated is mobilised and its covering pad of lesser omental fat is dissected free until the base of the ulcer can be clearly and indisputably identified. The stomach is then elevated and steadied with Allis forceps and the ulcer completely destroyed with a Paquelin, Post or other suitable cautery.

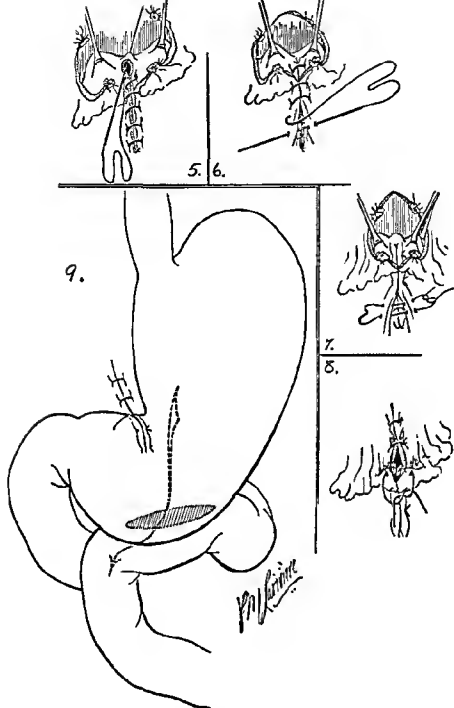


FIG. 70.—EXCISION OF CHRONIC GASTRIC ULCER COMBINED WITH GASTRO-JEJUNOSTOMY.

The method of suturing the defect in the stomach wall following excision of the ulcer is shown in (5), (6) and (7). The edges of the gastro-hepatic omentum are drawn together with a series of interrupted sutures, as shown in (8).

(9) Diagram of the parts at the completion of the operation. Note the position of the posterior gastro-jejunostomy.

The opening in the stomach is then closed with catgut sutures and reinforced with a continuous suture of the same material, the suture line being covered over with adjacent gastrohepatic omentum to protect and conceal it as well as to constitute a barrier against the formation of adhesions which might interfere with the mobility of the stomach. Gastro-jejunostomy then completes the operation.

Balfour's method has much to commend it, especially for the small remote ulcer in patients who are poor surgical risks. The cautery chars a minimal amount of gastric wall and the suturing of the defect does not interfere with the motility or the functioning of the organ. In addition to this the heat effectively destroys any malignant cells which may be present in the ulcer margins.

Balfour employed this method in 296 cases with a mortality of 3 per cent, and obtained 85 per cent of cures. Cancer of the stomach followed in 10 cases, 3.3 per cent, and recurrent ulceration in about 2 per cent.

Segmental or Sleeve Resection. This procedure has also been called the Reidel-Rodman operation, annular gastrectomy, mid-gastric resection, cuff excision, and segmental resection, as it involves the removal of a cylindrical portion of the stomach including the ulcer, this procedure being followed by end-to-end anastomosis between the distal and proximal segments.

Sleeve resection has a very limited scope of usefulness, being occasionally employed for hour-glass constriction or bleeding peptic ulcer involving the mid-gastric region, as it is simple and fairly safe in execution. The eventual results are inferior to those which follow the Polya types of gastrectomy, as the motility of the stomach is often impaired and recurrent constriction and ulceration at the same site are by no means uncommon. The operation is performed as follows:

The lesser and greater curvatures of the stomach are freed from the omenta as widely as seems necessary, and both gastric arteries and both gastro-epiploic arteries are doubly ligated and cut at the limits of the area chosen for resection. A cuff of the stomach which has been denuded of its blood supply is lifted upward, dissected free from the pancreas (should there be any attachments there), and a hot moist pack placed in the lesser sac behind the stomach. At the cardiac and pyloric ends of this cylindrical portion two pairs of clamps are placed, and between each pair the stomach is divided with a dia-

thermy needle and the segment removed. The two outer clamps are then brought together to permit of an easy anastomosis between the two gastric segments. The divided ends of the stomach should be of about equal size. If the pyloric portion is narrow, the pyloric clamp should be placed obliquely so that after the performance of the sleeve resection there is a longer section of stomach from the greater to the lesser curvature.

The two parts of the stomach can usually be drawn together easily and without producing tension. If, however, difficulty is experienced in approximating these two segments or if it seems likely that tension will follow the making of the anastomosis, this method should be abandoned, the remaining portion of the pylorus removed, and the operation completed by the Polya technique.

The end-to-end anastomosis is performed in a similar manner to that of gastro-jejunostomy, three continuous sutures being used. The suture line on the anterior aspect of the stomach should be buried by a seromuscular Cushing right-angled stitch which effectively invaginates the anterior suture line and prevents the stomach from becoming subsequently attached to the peritoneum of the anterior abdominal wall. When the operation is completed the surgeon should adopt Pannett's plan of performing a pyloroplasty after the method of Horsley in order to aid the emptying of the stomach and to relieve any strain on the suture line.

Excision of the Pyloric (Gastric) Ulcer Combined with Pyloroplasty. This operation is only indicated when on account of decrepitude or extreme obesity of the patient partial gastrectomy is considered inadvisable and when in addition to this a gastric ulcer is conveniently small and conveniently situated on the anterior wall of the antrum close to the pyloric ring. In addition to this the duodenum must be of ample size and capable of being easily mobilised. Wide excision of the ulcer is necessary owing to the fact that prepyloric lesions are often malignant in character.

The operation is conducted as in Judd's pyloroplasty or Finney's gastro-duodenostomy. The late results following this procedure are definitely inferior to those of partial gastrectomy.

Partial Gastric Exclusion. This operation of Devine's is limited to ulcers of the pyloric segment which are deeply penetrating the liver or pancreas and which are associated with a marked degree of

surrounding inflammation. Here partial gastric exclusion is the most effective of all methods as the primary step in a two-stage gastric resection. At the second operation three weeks after the exclusion it will be seen that the inflammation about the ulcer and neighbouring stomach wall has subsided to such a striking degree that the resection of the pyloric segment and duodenal bulb becomes greatly simplified.

Partial Gastrectomy. The standards of surgical treatment should be based upon the course which offers the best results in competent hands. In my opinion partial gastrectomy is the operation of choice for all gastric ulcers whenever it can be carried out without undue risk. When owing to the size or situation of the ulcer or to the general condition of the patient the risks of a radical resection appear to be prohibitive the surgeon has the choice of other procedures, from which he will have to select very wisely.

I have endeavoured to indicate the circumstances in which wedge excision or cautery destruction of the ulcer combined with gastro-jejunostomy, partial gastric exclusion, excision alone, or gastro-enterostomy alone may be reasonably employed.

Partial gastrectomy is the operation of choice in cases of chronic gastric ulcer for these reasons:

1. It affords the maximum protection against recurrent ulceration, hæmorrhage, perforation, obstruction, and the subsequent onset of carcinoma of the stomach. Recurrent ulceration following operations for gastric ulcer is rare and is seen in only about 2 per cent of cases following gastric resection. Cancer of the stomach, as I have previously stated, is the chief factor to be reckoned with in estimating the life-expectancy of patients operated upon for peptic gastric ulcer. Balfour (*The Stomach and Duodenum*, 1935) has shown that in 130 cases in which partial gastrectomy was performed for chronic gastric ulcer there were four—or 3 per cent—of subsequent deaths from cancer; in 293 cases in which cautery excision plus gastro-jejunostomy was carried out there were 10—or 3.3 per cent—subsequent deaths from cancer; while in 172 cases in which wedge excision plus gastro-jejunostomy was performed there were 11—or 6 per cent—subsequent deaths from cancer.

2. The immediate and late results are eminently satisfactory and the operation is in every way consistent with sound health and good digestion. Fully 90 per cent of patients show unimpaired efficiency

for work and have nothing of which to complain except that they must eat moderately for the first few months following the operation. The unsatisfactory results comprise less than 10 per cent and include a few cases in which microcytic anemia developed and which was speedily cured by the administration of ferrous salts and suitable food, and some 3 per cent of cases in which cancer developed in the remaining portion of the stomach. Moynihan (*Essays on Surgical Subjects*, 1921) whose "choice of operation is always gastrectomy when it can with reasonable safety be performed," records the lowest operative mortality—about 1.6 per cent; Finsterer (*Brit. M. J.*, 2:556, 1926), who regards no ulcer as irremovable and who in practice resects almost every ulcer however difficult of access or fixed in position and whatever the age of the patient, has an operative mortality of 2.7 per cent. The following operative mortality rates are also recorded: Donati 2.7 per cent; Flörcken 2.9 per cent; Morley. 2.9 per cent; Eiselsberg Clinic 3 per cent; Madlener 3 per cent; de Takats 3.3 per cent; Gordon-Taylor 4.2 per cent; Mayo Clinic 5.4 per cent; Finochietto 5 per cent; von Haberer 6 per cent; Bastianelli 6 per cent; and Pannett 6 per cent. In my own cases the mortality of partial resection is under 4 per cent, but for the large penetrating lesions it has been as high as 8 per cent.

3. The technique of the operation greatly simplifies the removal of the ulcer. On the other hand, it is well known that wedge-excision presents many technical difficulties; the resulting aperture is not easy to close, and the suturing produces some distortion of the stomach and interferes with its functional capacity, although this is in part overcome by the added short-circuiting procedure.

4. Partial gastrectomy is accepted by the majority of abdominal surgeons throughout the world as being the most satisfactory and successful undertaking in such cases. When, however, we come to discuss the technical details of partial gastrectomy we find sharp differences of opinion existing among surgeons of various clinics. The choice obviously lies between some variety of Polya gastrectomy in which the cut end of the stomach is anastomosed to the side of the first jejunal loop or some form of Billroth I operation in which the remaining gastric stump is anastomosed to the first part of the duodenum. Morley very rightly states that there is no fundamental principle involved and that every surgeon will tend to have the best

results from the performance of the type of operation in which constant practice has steadily improved his technique. Morley writes:

My own preference is decidedly in favour of that modification of the Billroth I operation associated with the name of Shoemaker. It has the advantages that it is simple to perform, it is less destructive of gastric function than the Polya operation, and it is therefore less liable to be followed by a severe degree of achlorhydric anæmia. I repeat that each surgeon will be guided chiefly by his practical experience. My own experience is that the Shoemaker gastrectomy is the safer operation. For gastric ulcer I have performed the Polya operation only forty-seven times with three deaths, a mortality of 6.4 per cent, while I have performed the Shoemaker operation 171 times with five deaths, a mortality of 2.9 per cent.

I submit that a method of gastrectomy involving a mortality of less than 3 per cent is getting near to the ideal that it should be as safe as gastro enterotomy. The convalescence is always smooth and uneventful, and the late results are good in a very high proportion of cases. I have a record of only one anastomotic ulcer following the Shoemaker operation in my own series. For the large ulcers extending high up on the lesser curvature I find this operation rather more feasible than the Polya, because one is not compelled to use the fibrosed lesser curvature adjacent to the ulcer in making the anastomosis.*

Joll, on the other hand, considers that

There is little to be said in favour of the Billroth I operation for gastric ulcer. At best it can only be used for ulcers low down on the lesser curvature or near the pylorus, and, while the danger of leakage can be almost entirely obviated by proper technique, the stomach which has thereby acquired an appearance of anatomical reconstruction does not, in my opinion, function satisfactorily. The mobility of the stomach is impaired and ulceration often recurs, not to mention the inadequacy of the resection, should the ulcer already have undergone malignant changes, which is specially liable to be the case in ulcers near the pylorus.*

The choice of operation is therefore a personal matter, and the indications for the Billroth I types of repair for peptic ulcer will be seen to depend mainly upon the skill and experience which the surgeon may possess in carrying out this procedure. It is generally conceded, however, that it presents more technical difficulties than the Polya types of operation and that these difficulties may be responsible for fatal consequences or troublesome post-operative sequelæ.

* Morley, *Brit. M. J.*, 1:315, 1937.

* Joll, *Post Grad. Med. J.*, 12:370, 1936.

The operation has, to my mind, one important advantage which has not received sufficient attention, in that the operative field is limited to the supra-colic compartment. When the duodenum is capacious and mobile I would regard the Billroth I method as particularly applicable in elderly and feeble patients, since the operation can be conducted with the minimum amount of disturbance and very expeditiously.

I prefer the techniques of von Haberer and Finochietto to the others which I have described (see pages 242 and 243).

The technical details of partial gastrectomy for gastric ulcer by the standard Polya methods do not differ in many essential details from those of the operation for duodenal ulcer which is described on page 241. Where, however, the ulcer is large and malignancy is suspected, it is advisable to make the operation as radical as possible. In such cases I detach the great omentum from the transverse colon, as originally advised by Hey Groves, and remove it intact with the portion of stomach that is resected.

Mobilisation of the duodenum in cases of gastric ulcer presents no difficulties and when accomplished the duodenum is divided about $1\frac{1}{2}$ inches from the pyloric outlet and its distal cut end is closed and securely invaginated. The right and left gastric arteries and the right and left gastro-epiploic arteries are ligated and divided, as in the classical operation; the glands around the pylorus and along the greater and lesser curvatures and in the region of the coeliac axis are dissected free and removed or remain attached to the resected gastric segment; and the stomach is clamped high up, fully 1 inch beyond the ulcerated area and surrounding indurated zone to ensure that fully two-thirds of the organ are removed together with the ulcer and the "invaded" tissues which lie close to it.

Should the anastomosis be made retro- or ante-colic? Clinically there is little to choose between these two methods, although theoretically the posterior operation would appear to offer certain advantages. Should the top half of the cut end of the stomach be closed as in the Hoffmeister-Finsterer operation, or should the whole of the cut end be used in performing the anastomosis? This depends upon the size of the cut end of the stomach. If it is normal or somewhat small in size, the whole of the cut end should be utilised in the anastomosis; if, however, the cut end of the stomach is large or

the excision has been made very high so as to include practically all the lesser curvature, then it is better and safer to close the top half.

I think that too much stress has been laid upon the value of the gastric valve which directs the stomach contents into the distal

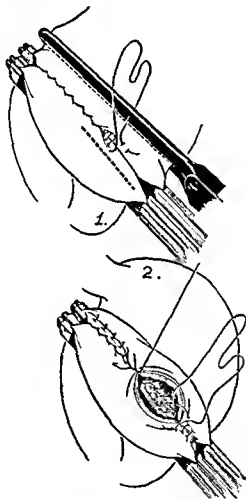


FIG. 71.—PARTIAL GASTRECTOMY FOR CHRONIC GASTRIC ULCER.

Anastomosis is being performed with the aid of enterostomy clamps. Only the lower half of the stomach is being utilised in the anastomosis, the upper half being closed after the method originally suggested by Hoffmeister.

jejunal limb. Nevertheless, I often employ this method of Finsterer's, as I find it convenient to close the top half of the cut end of the stomach when the resection has been very extensive. It simplifies the operation, it permits of a free inversion of the weak, thin, and

somewhat inaccessible portion of the stomach, it reduces the stoma to reasonable proportions, it prevents "dumping" stomach, and as the anastomosis is made to the lower end, *i.e.*, to a portion which can be easily drawn through the wound without hindrance, the suturing can be carried out with the greatest ease and precision. If the cut end of the stomach is small, no useful purpose can be served by reducing its size even further.

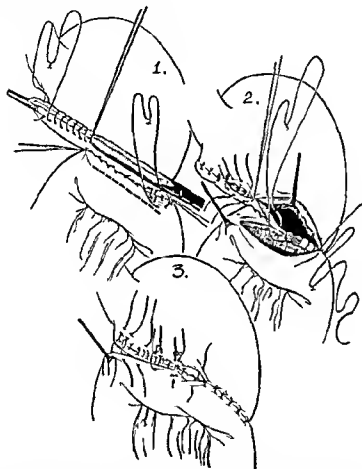


FIG. 72.—PARTIAL GASTRECTOMY FOR CHRONIC GASTRIC ULCER.

Anastomosis is being performed without the aid of enterostomy clamps. The upper half of the cut end of the stomach is closed and the lower half is being anastomosed to the proximal jejunum.

Figure 71 shows how the anastomosis is conducted when clamps are used, and figure 72 illustrates the method of suturing when intestinal clamps are not employed.

It is important to select the proximal jejunal loop carefully and to see that it is neither too long nor too short, and to arrange it in such a manner that it passes upward to its place of attachment to the stomach easily without any tension or drag and yet without any undue slack. The proximal point of the jejunal loop to be anastomosed to the stomach should be at the lesser curvature, while the distal point should be at the greater curvature. It is wise practice to reinforce the anastomotic line anteriorly and posteriorly, and especially in the region of the "dangerous angle," with interrupted sutures of fine silk (see fig. 72 [3]).

Total gastrectomy is never justifiable for gastric ulcer. In those cases in which the ulcer lies particularly high on the lesser curvature, Pauchet's method can often be successfully employed (see page 275), or the line of gastric section may be made vertical, permitting complete removal of the lesser curvature and at the same time preserving a fair portion of the body and the whole of the fundus of the stomach.

Cholecysto-Gastrostomy. This operation, which is associated with Braithwaite's name, has at times been employed in the treatment of chronic gastric ulcer on the assumption that bile has a neutralising effect upon the acid gastric juice. Bile is a neutral or only faintly alkaline fluid, and it is very questionable whether the amount which enters the stomach is sufficient to cause any neutralisation at all. It would seem that very little bile finds its way into the gall-bladder and thence on to the stomach, but that it rather travels along the common bile duct—when this is not narrowed—into the duodenum, the line of least resistance. This is confirmed by Nasarov who investigated a number of cases upon which this operation had been performed. He showed that reduction of the gastric acidity was very much less than might have been expected, and that *hyperchlorhydria* often persisted. The gastric juice has free access to the interior of the gall-bladder, and it is not surprising to find cases of peptic ulcer of the gall-bladder itself and of acute suppurative cholangitis reported after the performance of this operation.

Jejunostomy. Jejunostomy is occasionally recommended by some surgeons for large penetrating ulcers involving the lesser curvature near the cardia, for the highly placed posterior wall ulcers associated with hæmorrhage, debility, severe pain and backache, and for those rare cases in which at operation, owing to the extensive fixation of

the stomach, simple excision of the ulcer or gastro-enterostomy alone is not a feasible procedure.

The object of jejunostomy—which should be performed by Witzel's method—is to put the stomach at rest and so effect healing of the ulcer. But the stomach is a tireless worker and cannot by any means be put to rest. This has been shown by Ivy who demonstrated that the mere thought or sight of food stimulates a copious flow of gastric juice, and the introduction of food into the jejunum produces the same effect. If therefore this operation is performed for the type of ulcer under discussion, the jejunostomy feeding should be accompanied by the oral administration of alkalis, belladonna and fresh cream in order to neutralise and inhibit the secretion of gastric juice. The jejunostomy tube should be left in position for many months and the progress of the ulcer checked up by frequent X-ray examinations.

CHAPTER 11

PYLORIC OBSTRUCTION

In this chapter I shall deal only with actual pyloric stenosis or mechanical narrowing of the outlet of the stomach from intrinsic or extrinsic causes. The non-surgical conditions which produce intermittent gastric retention, such as reflex pylorospasm, migraine, etc., will not be considered.

CAUSES OF PYLORIC OBSTRUCTION

1. Intrinsic:

- (a) Chronic peptic ulcer: (i) pyloric; (ii) duodenal.
- (b) New growths of the stomach: (i) carcinoma; (ii) polypus.
- (c) Hypertrophy of the pyloric sphincter muscle or simple fibrosis not due to ulcer.

2. Extrinsic:

- (a) Extensive adhesions due to perigastric suppuration.
- (b) Pressure on the pylorus or on the duodenum by a diseased neighbouring viscus, such as the head of a pancreas which is cancerous.
- (c) Traction upon or kinking of the first part of the duodenum, e.g., by floating kidney, gastropptosis, etc.

ÆTIOLOGY AND PATHOLOGY

1. **Peptic Ulcer.** Chronic duodenal ulcer is the commonest single cause of pyloric obstruction, while cancer of the pyloric segment of the stomach occupies second place. It is computed that from 15-25 per cent of cases of chronic duodenal ulcer produce pyloric stenosis. The condition is more frequently seen in men than in women, as duodenal ulcer occurs more frequently in the former sex. It is the posterior rather than the anterior ulcer which is the principal cause of the stricture. The posterior ulcer which defies all attempts at cure

by medical means sooner or later becomes attached to and finally penetrates deeply into the substance of the pancreas, leading to the production of an extensive degree of local and surrounding fibrosis. The position and nature of such an ulcer, *i.e.*, near to the pylorus, large, excavating, inflamed and swollen with œdema, is of itself sufficient to produce obstruction. In nearly half the cases the ulcer itself will be found at operation or at autopsy to be completely healed. In long-standing cases the hard, scarred and distorted bulb may be firmly riveted to the sclerosed pancreas or may be dragged upward beneath the liver and bound there by fibrous adhesions, or again it may be loosely attached posteriorly by long stretched avascular membranes or bands. The indurated tumour in the pyloric region, greyish-white and puckered, may resemble a cancerous lesion, and it is at times very difficult to distinguish between the two conditions. The veins of Mayo become obliterated, the pyloric ring merges into the cartilaginous mass, stippling may be absent, and all the dependable landmarks are lost. On invaginating the duodenum with the index finger some clue as to the nature of the lesion may be gained; for instance, in carcinoma the elevated and everted rampart-like edge of the crater may be felt, and little pearly seedlings of growth may be visible in the serosa near the stricture.

In most cases of pyloric stenosis the causative ulcer has been present for many years; but the duration of the symptoms is dependent in part on the precise anatomical site of the ulcer. For example, when the ulcer is situated in the pyloric canal or actually abuts against the pyloric ring, the advent of obstructive symptoms is not long delayed. The moment obstruction supervenes, the stomach hypertrophies owing to the added work imposed upon it. The hypertrophy, which always starts at the pylorus, extends from this point into the body, and may even involve the lower reaches of the œsophagus. Unless the obstruction is relieved, dilatation of the whole stomach will follow, until eventually it becomes saccular and loses all normal anatomical divisions. In advanced cases the dilatation may be enormous and the organ occupy the greater portion of the abdominal cavity or even sink down into the hollow of the pelvis.

2. New Growths of the Stomach. There are two common types of pyloric cancer, both of which produce obstruction—the papilliferous or cauliflower-like mass, and the slow-growing scirrhus carci-

noma. The former may, by its massive fleshy bulk, plug the outlet of the stomach, but is a less frequent cause of obstruction than the scirrhus cancer of the pyloric canal, this being a comparatively common cause of blockage, as this slow-growing form of neoplasm is associated with an extensive degree of fibrosis and gradual contraction of the cylindrical pylorus. When fully developed, it converts the antrum and pyloric canal into a densely hard, narrow, thick-walled tube, and produces a very gradual stretching of the whole of the stomach. It is easy to mistake this type of growth for that rare condition—hypertrophy of the pyloric sphincter or simple fibrosis not due to ulceration.

A polypus may act as a ball-valve when it has a long stalk and thus produce obstruction, or it may pass bodily through the pyloric ring into the duodenum, dragging the stomach wall with it, thus causing intussusception of the stomach.

3. Hypertrophy of the Pyloric Sphincter. Cancer of the body of the stomach, gastric ulcer on the lesser curvature, chronic appendicitis, chronic cholecystitis, visceroptosis, epigastric hernia, and other abdominal conditions may produce reflex pyloric spasm, but there is no available evidence to show that such spasm can cause marked and permanent hypertrophy of the pyloric sphincter or a fibrous stenosis. Occasionally a marked degree of muscular hypertrophy of the pyloric muscle associated with obstructive phenomena is encountered at operation, and the condition may at this juncture be regarded as malignant. Again, a simple stricture or fibrous thickening may be found in the pyloric canal without any evidence—microscopic or otherwise—of previous ulceration. Walton (*The Surgical Dyspepsias*, 1930) considers it possible that a certain proportion of these are cases of congenital hypertrophic pyloric stenosis which have survived to adult life, as a number of such cases have now been recorded in which the pathological features of the pyloric tumour are in every way identical with those of infantile stenosis.

4. Perigastric Inflammation. Acute cholecystitis with gall-stones, sub-acute perforation of a chronic peptic ulcer, and pancreatitis are the commonest causes of perigastric inflammation and the most likely to produce pyloric obstruction. This obstruction, however, is usually not of a very severe nature and rarely becomes complete. In severe cases of acute obstructive cholecystitis the duodenum, the pylorus,

the hepatic flexure of the colon and the great omentum may become fused to the gall-bladder and liver in a hard fixed lump which may, on clinical examination, resemble a carcinomatous growth or a localised perigastric abscess. Compression of the first part of the duodenum may take place during this acute phase, but this is more likely at a later date during ulceration owing to the slow contraction of the massive surrounding adhesions.

Gall-stones may be a cause of pyloric stenosis. In cases of cholecystitis accompanied by calculi, the duodenum may become adherent to the gall-bladder and a gall-stone—usually a large barrel-shaped one—may ulcerate through the contiguous walls and pass into the intestine. If very large, it may remain impacted in the duodenum itself and give rise to an acute abdominal catastrophe, demanding immediate surgical interference. If it passes on it may become lodged somewhere in the last foot or two of the ileum where the gut narrows and where impaction so frequently occurs, causing acute intestinal obstruction. The site of perforation eventually becomes the site of the obstruction.

5. **Pressure on the Duodenum or Pylorus by a Diseased Neighbouring Viscus.** Carcinoma of the head of the pancreas, chronic pancreatitis, disease of the gall-bladder and bile ducts, duodenal diverticula, cancer of the hepatic flexure of the colon, new growths and cysts of the liver, etc., may so compress the pylorus or duodenum as to give rise to serious obstructive symptoms.

6. **Traction upon or Kinking of the Duodenum.** A floating kidney may drag the attached duodenum downward and produce temporary kinking of the gut, thus causing obstruction and one of the varieties of Dietl's crisis. In gastroplosis the duodenal bulb may become flattened out when the large, dilated, heavily laden, hypotonic stomach unduly drags upon its fixed attachments and so produces a severe degree of gastric stasis.

SYMPTOMS AND SIGNS

There are, as we have seen, many causes of mechanical pyloric obstruction, but once the condition becomes chronic there is little variation in the symptoms produced. The symptoms are due to three factors:

(1) Stoppage at the outlet of the stomach; (2) secondary gastritis; and (3) biochemical disturbances.

When peptic ulcer is the causative factor the history alone will supply an important clue to the diagnosis, as symptoms typical of ulcer will in most cases be found to have been present for a period of many years. On careful questioning, therefore, the majority of patients will give a history of duodenal ulcer, but with the onset of pyloric obstruction the characteristic symptoms of peptic ulcer will have disappeared and there will be no intermissions nor will there be any period of freedom from symptoms.

The chief symptoms are pain, vomiting, anorexia, loss of weight and obstinate constipation. As soon as pyloric stenosis supervenes, true hunger pain ceases and is replaced by pain which is more or less continuous but of a distinctly milder nature. Food aggravates the pain, as will also the first meal taken after a bout of vomiting or after the stomach has been washed out. Superadded upon this dull but tolerable pain there will be intermittent bouts of colic which may in time develop into severe cramp-like spasms in the epigastrium—tetany. Tetanic contractions of the stomach indicate an advanced stage of obstruction, and when present are pathognomonic of the condition. It should be noted that the intake of food aggravates the pain but never relieves it; in fact, it is only after vomiting or after the stomach has been emptied by a tube that relief is afforded. Such patients will therefore often resort to self-induced vomiting or become very practised and adept in the use of a stomach tube. More pain is experienced at night when the stomach has become distended with the accumulation of food taken during the day.

Vomiting is one of the most outstanding symptoms of pyloric obstruction. At first it is fairly frequent, once or twice a day, and this continues as long as the stomach is able to maintain its condition of hypertrophy. As dilatation supervenes, the intervals between the bouts of vomiting become longer, but the amounts ejected are more copious. In a severe case, if the stomach is completely emptied through vomiting or by means of a stomach tube, it has been observed that it may take one or two days or sometimes more for it to refill to full capacity.

As the dilatation becomes worse, the stomach, as the result of atony and stretching, is capable of retaining very large quantities of

decomposing material, even amounting to several pints or quarts. The withdrawn fluid is foul, frothy, fetid and fermenting, and often contains particles of food known to have been ingested several days previously.

When the obstruction is due to simple ulcer the appetite may in the early stages be good; but as obstruction increases it becomes less, until eventually there is anorexia which is due partly to gastritis and partly to the patient's fear that partaking of food will bring on an attack of vomiting. There may be such a complete loss of appetite in late cases that this symptom combined with the physical findings may suggest to the clinician that the patient is suffering from advanced malignant disease of the stomach.

Thirst is a common symptom and is increased by vomiting. Here again the patient often abstains from drinking as he attributes his vomiting to the intake of water or fluid nourishment. The progressive loss of weight is due to anorexia, vomiting, self-induced starvation, or to a combination of all three. Loss of weight is accompanied by marked dehydration of the tissues, which is evidenced by the parched and inelastic condition of the skin. As is usual with such substantial loss of weight, there is weakness, giddiness, lassitude, drowsiness and headaches, and other features associated with a pronounced intoxication. Constipation is usually very marked, and this is due to the small quantities of food and fluid which are capable of passing the obstructive lesion. The urine is always scanty, concentrated, and often contains acetone bodies.

DIAGNOSIS

Clinically, the diagnosis of pyloric obstruction is not of itself very difficult, but in establishing the exact cause of the underlying condition resort will have to be made to X-ray and laboratory methods of investigation.

On examination, wasting is evident, the extent depending upon the degree of obstruction present and the length of time it has existed. Contrary to expectation, wasting is more marked in benign obstruction than in obstruction due to malignant disease, and this is due to the fact that in the former condition the stenosis is more absolute and of longer duration. The patient will be found to be

emaciated and dehydrated, pale and somewhat drawn; the tongue will be coated and the breath foul, the result of gastric fermentation.

The signs which accompany chronic intoxication will, as I have just remarked, be in evidence. The abdomen is often distended in the upper half and contracted or scaphoid in the lower half; but where dilatation is advanced the whole abdomen becomes blown out. The area of stomach resonance is diminished and its extent will be found to vary according to whether the patient is lying down or standing up. Visible peristalsis is occasionally seen, the waves passing from left to right in the epigastrium, emerging from beneath the left costal margin and sweeping across to disappear to the right side of the umbilicus. Gurgling and splashing stomach sounds due to peristalsis, palpation of the stomach or movement of the body, may also be audible. The dilated stomach is tender on pressure and this is particularly so in the epigastrium where the rectus muscles in their upper halves are frequently tensely on guard.

There should be a systematic search made for an abdominal tumour, especially in the region of the pylorus. If on examination a tumour is found in the pyloric region, its physical characteristics may proclaim its nature; but this is not always a reliable sign. A small, tender, movable and somewhat ill-defined lump is suggestive of a benign obstructive lesion, while a stony-hard craggy mass is typical of cancer.

Tetany is only to be found in severe cases, and when present there will be evidence of alkalosis.

An X-ray examination of the stomach and duodenum after the administration of a barium meal is the most valuable of all methods of investigation and is essential in clinching the diagnosis. Skiagrams will not only demonstrate with the greatest accuracy the degree of obstruction present but also the causative lesion, its nature and its position. The more dilated the stomach, the more likely the diagnosis of benign stenosis, although this is not invariably the case.

The passage of a stomach tube and aspiration of the stomach contents will afford the greatest help, as the enormous quantity withdrawn and analysis of its physical and chemical characteristics will not only suggest a blockage of the outlet of the stomach but will often provide a differential diagnosis between benign and malignant stenosis.

The response to medical treatment, too, will provide a useful clue as to whether the clinician is dealing with scar stenosis or with stenosis due to œdema and spasm. In the former, gastric analysis will show an absence or at least a great diminution in the acid values, while in the latter, following a course of gastric lavage the gastric juice often returns to its pristine state and will be rich in hydrochloric acid.

Examination of the stools may also be of value. For instance, in a case of duodenal ulcer causing pyloric stenosis and confirmed by X-ray examination, repeated positive occult blood tests will prove that the ulcer is still in a state of activity. I have previously stressed the necessity of a complete blood examination in order to determine the degree of toxæmia present, and how the blood chemical changes have been influenced by the treatment instituted.

DIFFERENTIAL DIAGNOSIS BETWEEN BENIGN AND OTHER TYPES OF PYLORIC OBSTRUCTION

1. **Carcinoma of the Pyloric Segment of the Stomach.** In this case there is usually a short history—less than one year, obstructive symptoms being abruptly ushered in comparatively early in the course of the disease. Wasting, although present, is not so marked as in benign obstruction, and the advent of anorexia and nausea almost coincides with the onset of the growth.

The history of gastric upset after food is likewise short, unlike cases of simple stenosis in which there may often be a previous history of typical hunger pain dating back for many years. A hard tumour may be felt in the pyloric region, the nature of which will be revealed by X-ray examination.

2. **Carcinoma of the Head of the Pancreas.** It is only at a very late stage in this disease that any degree of obstruction of the duodenum occurs. By this time the patient will be deeply jaundiced on account of the condition of the common bile duct or of the ampulla of Vater. The hard mass in the pancreatic head may be palpable, as may also be the enlarged, tense gall-bladder which moves with the swollen liver on respiration.

3. **Perigastric Inflammation.** This is commonly due to acute obstructive cholecystitis. A large fixed mass will be found in the region

of the gall-bladder which is continuous with the liver above and moves slightly upward and downward on respiration. There will be muscular rigidity and tenderness over this area, in addition to the usual constitutional signs and symptoms.

When the omentum, hepatic flexure and pylorus become adherent to the inflamed structures in this region, a large tumour may be formed which may be indistinguishable from that of carcinoma. A carcinoma, however, which is large enough to infiltrate the liver by direct spread must be in a very advanced stage and of such long standing as to produce obstruction of the colon and metastases in the liver and elsewhere. The history will be helpful, as in perigastric inflammation there will be a story of gall-bladder trouble or possibly of intermittent attacks of colic followed by jaundice.

4. **Obstruction due to Kinking of the Pylorus and Duodenum.** In such cases visceroptosis is evident and on physical examination a mobile right kidney can easily be identified. The stomach will be found to be large and sinking downward into the pelvis. The obstructive symptoms are incomplete and irregular, and are characterised by short sharp acute attacks which last for very brief periods. Although during an attack vomiting may be severe, it only lasts for a few hours or at most for a day or two, being followed by periods of complete freedom from any trouble. During a bout of vomiting, the nature of the vomited material and the total amount voided will differ considerably from that seen in cases of long standing organic obstruction. The vomited material, which is small in amount, does not show the characteristic features of decomposition and fermentation. The effect, moreover, of posture in producing relief of symptoms is more marked. Pyelograms and a barium meal examination of the stomach will settle the diagnosis.

5. **Chronic Duodenal Ileus.** In some severe cases of duodenal ileus the vomiting may be so severe and intractable as to simulate pyloric stenosis. Fluoroscopic examination of the stomach, however, will determine the site of the constricting agent.

TREATMENT

The treatment of organic pyloric obstruction due to innocent and malignant growths is discussed on page 489. The management of

cases of acute obstructive cholecystitis in which gastric stasis is a troublesome feature is considered in some detail in the part dealing with diseases of the gall-bladder (see pages 747 and 753).

We have now to consider the best lines of treatment to adopt for those cases of pyloric obstruction due to long-standing duodenal scar stenosis in which there is some permanent narrowing of the intestine and for which further trials of medical treatment can no longer be countenanced, and for those cases of chronic duodenal ulcer associated with obstructive symptoms which are mainly due to pyloric spasm as well as extensive œdema of the gastric outlet and of the first portion of the duodenum.

1. **Treatment of Pyloric Obstruction due to Chronic Duodenal Ulcer Associated with Spasm and Œdema.** It is surprising how rapidly and successfully these patients respond to a well-regulated regime of medical treatment which includes rest in bed, frequent or continuous aspiration and lavage of the stomach, intravenous salines with glucose by the continuous drip method, daily evacuation of the bowels by means of enemata, the oral administration of fresh cream (vitamin A) and dilute saline draughts containing fresh lemon or lime juice (vitamin C), and blood transfusion. The dilated stomach rapidly contracts and regains its former virile tone, gastritis is cured, hydrochloric acid reappears in the gastric juice in good concentration, and the ulcer shrinks and commences to heal, œdema and spasm disappear, and the pylorus takes on its normal and regular physiological sphincteric duties once more by opening widely and contracting evenly in response to the stimulus of ingested food. Within a week the picture changes dramatically, and routine medical measures can be instituted with every hope of success; but when these measures fail to bring about permanent relief of symptoms or should there be frequent recurrence of attacks of obstruction, then operation must be advised.

The operation of choice for such cases is partial gastrectomy which ensures a permanent reduction of hydrochloric acid and which safeguards the patient against the recurrence of the symptoms.

2. **Treatment of Pyloric Obstruction due to Chronic Cicatrising Duodenal Ulcer Associated with Hypochlorhydria or Absence of Hydrochloric Acid in the Gastric Juice.** Here the operation of choice is gastro-jejunostomy. At the completion of the operation the scarred

duodenum is infolded with a Mayo-Kelling stitch and the appendix is removed if possible, this latter step being omitted if the patient's condition is feeble or if for some other reason it is deemed inadvisable to prolong the operation. Likewise, if a diseased gall-bladder is found it may be excised if the patient has withstood the short-circuiting operation satisfactorily. But in a number of cases it is often wiser to defer its removal until a later date when recovery from the first operation is complete.

Gastro-jejunostomy is best performed without the aid of intestinal clamps, but if these are used they must be applied with the greatest care and gentleness as the stomach is frequently greatly dilated and its walls are thin, stretched, oedematous and friable to a degree.

These results of gastro-jejunostomy for the condition under discussion are exceedingly good, in fact it may be said to be the most gratifying of all abdominal operations. The mortality is only 1 to 2 per cent, and 95 per cent of cures are recorded from numerous surgical clinics. The dreaded post-operative complication of jejunal ulcer is rarely seen—less than 2 per cent.

Gastro-duodenostomy has been performed as an alternative method to gastro-jejunostomy, but the final results do not seem to be so uniformly satisfactory. When gastro-jejunostomy is performed the stoma should be at least 3 inches in length to allow for the narrowing which will take place subsequent to the contraction of the stomach.

TECHNIQUE OF GASTRO-JEJUNOSTOMY

Since its introduction by Wölfler at Nicoladoni's suggestion in 1881 this operation has passed through many variations in the method of its performance until it has become more or less standardised and is practised in the same manner in almost every clinic throughout the world. Wölfler's first operation was an *anterior* long-loop anti-peristaltic gastro-jejunostomy, and this in 1885 gave place to von Hacker's posterior long-loop anti-peristaltic gastro-jejunostomy on the recommendation of Courvoisier. As obstructive symptoms were common after von Hacker's method, Braun in 1892, and later Jaboulay, introduced the addition of a lateral entero-anastomosis between the proximal and distal jejunal limbs to overcome regurgitant vomiting which was such a common sequel to the long-loop method.

von Hacker obtained better results by performing the new classical *anterior* long-loop iso-peristaltic gastro-jejunostomy plus Braun's entero-anastomosis. Roux's anastomosis in Y was first performed in 1897, and it was hoped that this operation would solve the problem of vicious-circle vomiting. But it was followed by such a high percentage of jejunal ulcers that it has been completely abandoned. Brenner (1892) was the first surgeon to perform a retro-colic anterior long-loop iso-peristaltic gastro-jejunostomy. The long proximal jejunal loop was brought through the opening in the mesocolon and gastro-colic omentum, and the jejunum was anastomosed to the pyloric segment of the stomach.

Stiles and Sherren, and at a later date Wilkie, improved upon Brenner's method by performing the operation without a loop and making a junction either to the anterior wall of the stomach or to its posterior surface parallel with and close to the greater curvature (fig. 73). This operation still has its indications as I shall later show. Petersen (1900) laid the foundation of the modern operation of posterior no-loop gastro-jejunostomy. Moynihan and the Mayos were among the first to observe the enormous advantages of Petersen's method which overcame in a most successful manner the great bugbear of the long-loop operation—vicious-circle vomiting, and they have by their masterly skill and judgment evolved a technique which has been widely adopted and still remains unsurpassed in its many details.

Today there is a compromise between the no-loop and the long-loop methods. When performing the posterior operation, the exact length of the loop will vary according to such factors as the build of the patient, the position of the stomach, and the amount of mobility which it possesses. In a stumpy, broad-chested individual, for instance, with a small high-lying, steer-horn type of stomach, the loop must of necessity be short, possibly 3 inches, as the stomach is in a more or less stationary position; if, on the other hand, a no-loop type of operation is performed upon a tall, thin, long-waisted, visceroprotic patient, the gastro-enteric stoma is held up at a higher level than the greater curvature of the stomach when the patient stands upright. In such cases, therefore, a comparatively long loop, say 4 to 5 inches, will be chosen, as the stomach lies low in the abdomen and has a wide range of movement.

The opening in the stomach may be made vertical (Moynihan), oblique (Mayo), or transverse (Kocher).

Moynihan's vertical stoma is made in the posterior wall of the stomach in line with the vertical portion of the lesser curvature and



FIG. 73.—STILES'S MODIFICATION OF BRENNER'S OPERATION.

The great omentum is partially detached from the transverse colon, and a loop of proximal jejunum, some 8 inches or so from the duodeno-jejunal flexure, is drawn across the transverse colon and sutured to the posterior aspect of the stomach close to the greater curvature at its most dependent portion. The first posterior seromuscular suture is being introduced.

with the right margin of the œsophagus. It stretches from the lesser curvature to the lowest point on the greater curvature (fig. 74). He insisted that a portion of the opening should be placed at the greater curvature to prevent the formation of a pool of stagnant fluid in the stomach. The jejunum is brought directly downward in a

straight line from the duodeno-jejunal flexure with a slight loop, and is applied to the stomach. W. J. Mayo, who makes an oblique stoma (fig. 74 A), anastomoses the jejunum to the stomach in an anti-peristaltic direction so that there may be no interruption in the line of the duodenum at the flexure. In Kocher's method the middle third

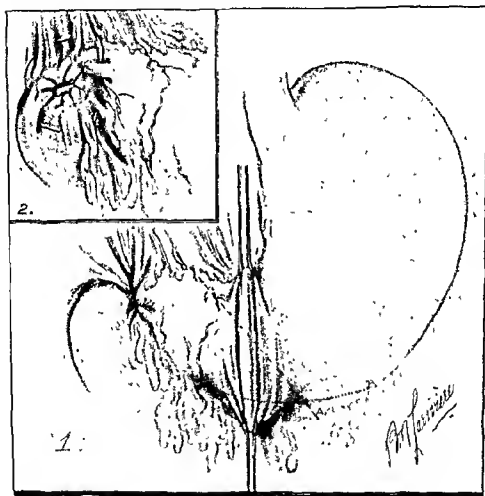


FIG. 71.—POSTERIOR GASTRO-JEJUNOSTOMY.

(1) The Allis forceps are applied to points on the lesser and greater curvatures to act as markers prior to making a vertical stoma. (A) indicates the line for the oblique stoma. (B) represents the position of the transverse stoma.

Note that the Mayo-Kelling suture has been tied, securely invaginating the scarred area of the duodenum and affording protection against perforation of the gut.*

(2) The Mayo-Kelling suture is inserted and ready to be tied.

of the great omentum is detached from the greater curvature, after which the proximal jejunal loop is drawn through an aperture in the mesocolon, and an iso-peristaltic or anti-peristaltic gastro-jejunostomy is performed at the greater curvature, the stoma lying transversely in line with the longitudinal axis of the stomach (fig. 74 B). When this anastomosis is completed, an imaginary line drawn perpendicularly downward from the right margin of the œsophagus should bisect the stoma into two equal parts.

In practice the majority of cases show little if any difference in the results of these various operations, whether the opening in the stomach is made vertical, oblique or transverse, provided some portion of the opening is placed, as Moynihan has stressed, at the greater curvature. In certain cases, however, there are distinct advantages in making a transverse stoma. For instance, if the stomach is very small and contracted, the distance from the greater to the lesser curvature is not sufficient to allow of an adequate stoma being made. After wedge-excision of a gastric ulcer a transverse opening placed at or close to the greater curvature ensures that the anastomosis is far enough away from the suture line. Also, in the modern Brenner type of operation the anastomosis is always made transversely on either side of or actually at the greater curvature (see page 335 for details of other methods).

The size of the stoma varies in individual cases. When the stomach is markedly dilated, the stoma must be correspondingly large, *i.e.*, about 3 to 3½ inches; although the usual size of the opening is 2½ inches, it should never be less than 2 inches or more than 3½ inches. In view of the subsequent contraction of the stomach and of the stoma itself which follows gastro-jejunostomy in cases of dilatation of the stomach due to pyloric stenosis, the anastomotic opening in such cases must always be of generous proportions. When the stomach is normal in size, however, no appreciable contraction of the organ occurs, in fact when such does take place it is usually due to the original opening having been made at too high a level where it functions imperfectly, or to the development of secondary ulceration. Such contraction, which may be clearly demonstrated on fluoroscopy, is always an ominous sign.

Posterior gastro-jejunostomy is performed as follows: The abdomen is opened through a median or paramedian incision of ample

length to permit of easy exploration of the abdominal viscera. After the scarred first portion of the duodenum has been inspected, the entire stomach, the remainder of the duodenum, the duodeno-jejunal flexure, etc., are methodically scrutinised for evidence of any other pathological lesion. After this the abdominal viscera are examined on the lines suggested on page 596. The stomach, transverse colon and the great omentum are then drawn through the wound and held upward by an assistant to allow inspection of the under-surface of the mesocolon and the position of the middle colic artery and its arching branches. The surgeon then passes his right hand along the surface of the mesocolon toward the left of the spine to pick up and identify the fixed duodeno-jejunal flexure, after which he withdraws some 6 to 8 inches of proximal jejunum through the wound, wraps it in a small abdominal towel soaked in warm saline, and lays it aside on the abdominal wall for use at a later stage in the operation.

Any slight adhesions which are found attaching the jejunum to the under-surface of the colon are divided. When, however, these adhesions are very extensive or if the jejunum is fixed for several inches to the mesocolon, it is better to leave the parts undisturbed and to abandon the posterior operation. In such circumstances anterior gastro-jejunostomy or some form of pyloroplasty would be a preferable procedure for an operation of this kind when surgery cannot be avoided.

The arrangement of the blood vessels in the mesocolon is carefully observed as, if these are numerous, aberrant or irregular in their arrangement or are obscured in fat, if an adequate bloodless space cannot be found in which to make the opening into the lesser sac, if the mesocolon is short or if it is fused to the peritoneum of the stomach bed, thus obliterating the lesser sac, the posterior operation should not be attempted. When conditions permit of the performance of the posterior operation, the first step should be the occlusion of the pylorus by a Mayo-Kelling suture (fig. 74 [2]). This is a purse-string suture of strong silk which surrounds the pylorus and the scarred duodenum and which picks up portions of the omentum above and below the lesion so that when the suture is tied it not only invaginates the anterior wall of the duodenum but covers it with a fatty omental pad, thus protecting the patient against acute per-

foration. The inverted gut wall acts well as a plug and produces a temporary pyloric occlusion for a period of about six weeks.

When the pylorus is satisfactorily occluded, the surgeon will have to decide whether he should make the stoma vertical, oblique or transverse. If transverse, some 4 inches of the most dependent portion of the greater curvature is selected, the omentum is stripped away from this area, and Allis forceps are clipped to the greater curvature at the extremities of the line of the proposed stoma to act as guides. If the oblique stoma is chosen, a pair of Allis forceps is placed on the lesser curvature, 1 to $1\frac{1}{2}$ inches to the right (pyloric) end of the incisura, and another pair of forceps picks up the lowest point of the greater curvature about 1 to $1\frac{1}{2}$ inches to the left (cardiac) side of an imaginary line drawn vertically downward along the free border of the vertical part of the lesser curvature and cutting across the greater curvature (fig. 74 A). The two forceps act as markers and help to indicate the direction that the stoma should take on the posterior surface of the stomach.

When the vertical stoma is selected, and this is the method I shall now describe, two pairs of forceps are fixed to the curvatures, one on the incisura and the other exactly opposite on the greater curvature (fig. 74). When these Allis forceps are in position, the surgeon draws the stomach, the transverse colon and the great omentum through the wound and holds the transverse colon upward to display the full face of the mesocolon. An opening is then made through the mesocolon into the lesser sac in a bloodless space which exists to the left of the middle colic artery and beneath its anastomotic arch. This is done by drawing the mesocolon away from the stomach and clipping it with a hæmostat at a bloodless spot. A snip is then made with scissors by the side of the clip into the lesser sac, after which the opening is further enlarged vertically to admit three or four fingers comfortably. This opening must not be too niggardly, never less than 3 inches long, and should permit of a complete exploration of the posterior aspect of the stomach and its bed. If any adhesions exist between the stomach and its bed, these should be freed and the organ adequately mobilised before proceeding with the anastomosis.

The portion of the stomach wall needed for the anastomosis is then drawn through the opening in the mesocolon. The Allis forceps on the greater curvature will now be seen at the upper end

(near the colon) of the opening, while the pair of Allis forceps on the lesser curvature guides and bulges a fold of stomach through at the lower end (near the duodeno-jejunal flexure) of the opening (fig. 75). The fold of stomach to be utilised in the anastomosis is again freely mobilised by division of the filmy adhesions and is drawn further through the opening in the mesocolon. The Allis forceps at the selected points on the greater and lesser curvatures at the extremities of the fold of stomach to be used in the anastomosis are elevated, while the edges of the opening in the mesocolon are stitched all around the stomach with a series of interrupted sutures (fig. 75 [2]). It is better to anchor the edges of the opening in the mesocolon to the stomach at this stage, as the suturing can be done more easily and more accurately than when the jejunal loop is in the way, as it will be at the end of the operation.

It should be noted especially that the mesocolon is stitched to the stomach wall itself, well beyond the area to which the jejunum will be attached and not to the finished suture line of the gastro-enteric stoma. It was formerly sutured in the latter position to act as an omental reinforcement, but this practice has been abandoned. By the former method the anastomosis is placed well into the greater peritoneal cavity, constriction of the stomach thus being rendered impossible.

If enterostomy clamps are used, the gastric fold is raised and clamped, the tips of the blades pointing to the patient's chin and the handles toward the pubes. The selected coil of jejunum is picked up and the portion chosen for the anastomosis, about 4 inches from the duodeno-jejunal flexure, is likewise clamped, after which the two clamps are brought together, side by side, and the parts are ready to be anastomosed (fig. 76).

When clamps are not employed, the anti-mesenteric border of the portion of jejunum chosen for the anastomosis is picked up with Allis forceps which are placed at a distance of 3 to 4 inches apart. The proximal point of the jejunal loop engaged in the anastomosis is applied to the lesser curvature of the stomach, while the distal point is applied to the greater curvature. The transverse colon, the omentum, and any intestines which have prolapsed through the wound are now replaced in the abdominal cavity and are prevented from protruding into the field of operation by means of suitably

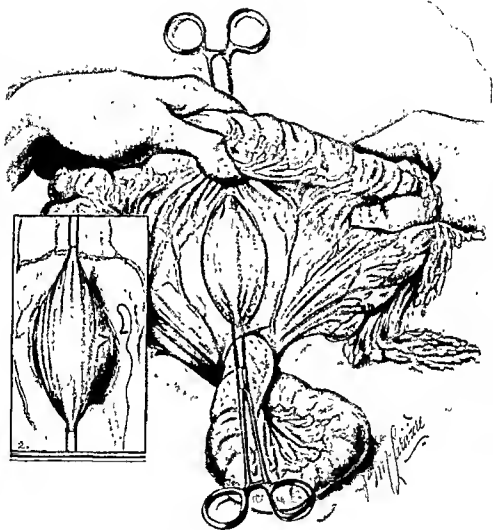


FIG. 75.—POSTERIOR GASTRO-JEJUNOSTOMY.

A vertical opening has been made in the mesocolon through one of the wide arches of the middle colic artery. The duodeno-jejunal flexure and the first vertical pouch of the opening of the

Inset: shows the edge of the mesocolon being sutured to the posterior wall of the stomach.

placed abdominal packs. The only portions of the viscera which are allowed to remain outside the abdomen are those about to be anastomosed.

The operative field is isolated with hot moist towels, over which waterproof squares are placed. The folds of stomach and jejunum are now kept taut and in close apposition and are steadied by an

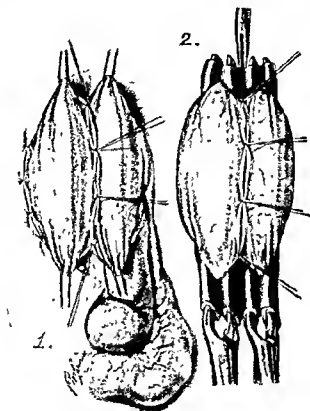


FIG. 76.—POSTERIOR GASTRO-JEJUNOSTOMY.

- (1) The operation is being performed *without* the aid of clamps.
- (2) The operation is being performed *with* the aid of clamps.

assistant who holds the upper and lower sets of Allis forceps in his fingers. Four interrupted sutures of fine silk are introduced to approximate the adjacent walls of stomach and jejunum, to prevent rotation of the jejunum and to act as suitable tractors (fig. 76). The first posterior suture is now introduced as a Cushing, right-angled stitch which unites the contiguous seromuscular coats of the stomach and

jejunum from the lesser to the greater curvature, and when it reaches the greater curvature it is locked once or twice and laid aside to be used again at a later stage in the operation (fig. 77 [1]).

Two longitudinal incisions are now made with a knife through the seromuscular coats of the stomach and jejunum down to the mucosæ, parallel with and $\frac{1}{4}$ to $\frac{1}{3}$ of an inch from the posterior suture line. The mucous membrane of the stomach and jejunum will pout through these incisions as the seromuscular coats retract and as they are freed by gentle dissection. A few large blood vessels, which can be seen coursing over the exposed surface of the gastric mucous membrane, are under-run and ligated on each side of the line of the proposed incision through the mucosa.

The second posterior stitch starts at the greater curvature end and is introduced as a continuous through-and-through all-coats suture. When it reaches the lesser curvature it is locked and put on one side (fig. 77 [11]). A small incision is made through the gastric mucous membrane, large enough to admit a suction tube, which is used to aspirate the contents of the stomach. The mucous membrane of the stomach is picked up with forceps and divided with scissors for almost the full length of the seromuscular incision. The jejunal mucous membrane is similarly picked up and incised, and the gut thoroughly sponged. Redundant gastric and jejunal mucous membrane is not excised, as such trimming may predispose to the formation of stomach ulceration.

The third continuous suture approximates the margins of the mucous membranes of the stomach and jejunum posteriorly, and when the suturing has been completed along the posterior margin of the incision it turns the corner at the lesser curvature and returns along the anterior margin as the first anterior stitch, without interruption, locking or knotting, until the end which was left long is reached, when a double knot is tied and the ends are cut short.

The second posterior suture is then taken up and returned as the second anterior suture, being passed as a closely applied continuous Lembert suture which invaginates the anterior suture line. When it reaches the greater curvature it is knotted and cut short (see fig. 78 [11]).

The third posterior suture is now picked up once more and introduced anteriorly as a Cushing right-angled stitch, and when it reaches

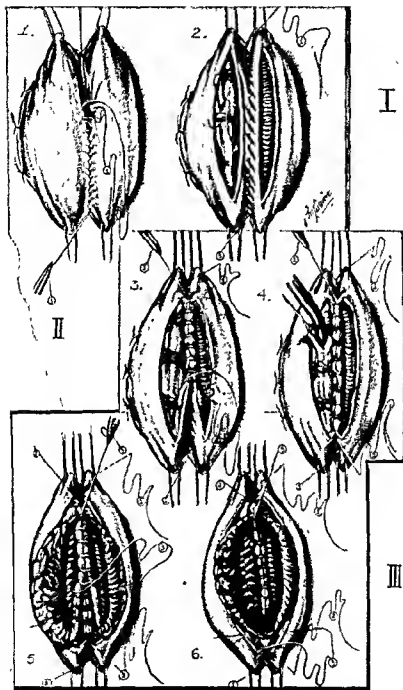


FIG. 77.—POSTERIOR GASTRO-JEJUNOSTOMY.

The method of introducing the three posterior sutures is depicted.

the lesser curvature is tied to the point where it was started (see fig. 78 [1]).

Curved or straight atraumatic intestinal needles are used and are threaded with No. 0 twenty-day chromic catgut. Four or five inter-

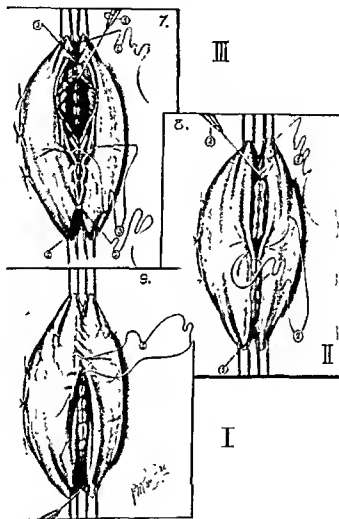


FIG. 78.—POSTERIOR GASTRO-JEJUNOSTOMY.

The method of introducing the three anterior continuous sutures.

rupted sutures of fine silk are introduced to reinforce further the anterior suture line. The surgeon and his assistants then change their gloves, and fresh instruments are used for closing the abdominal incision.

The operation is completed by replacing the colon and omentum into their normal positions and by testing with the fingers the size of the stoma.

In performing *anterior gastro-jejunostomy* a portion of the proximal jejunum, some 14 to 16 inches from the duodeno-jejunal flexure, is chosen for the anastomosis, a long loop being necessary as the distance from the flexure to the greater curvature of the stomach may be comparatively long and it is essential to prevent the transverse colon from being subsequently compressed by the afferent or efferent limbs of the jejunum. The length of the proximal jejunal loop will vary in individual cases. If the patient is thin, if the stomach is low-lying, if the transverse colon is well hitched up at the flexures, and if the omentum is flimsy, then a relatively short loop, say 14 to 16 inches, is selected. On the other hand, when the stomach is placed high up and is contracted and when the omentum is fatty and voluminous, a long loop will be necessary. The stoma should be at least 3 inches long and should be placed at the most dependent portion of the stomach, *i.e.*, transversely, precisely at or just anterior to the greater curvature. The opening is planned so that it is equally bisected by an imaginary line which is produced downward from the vertical portion of the free edge of the lesser curvature (fig. 79). It is, in my opinion, immaterial whether the portion of jejunum selected for the anastomosis is placed from the right to the left or from the left to the right along the greater curvature—*iso-peristaltic* or *anti-peristaltic*, as the results are equally good whichever method is employed.

The suturing is conducted as in the posterior operation, except that the first continuous seromuscular suture unites the stomach and jejunum over a greater extent than is required for the opening in order to avoid obstructive kinking of the jejunum. To prevent the establishment of vicious-circle vomiting, Braun's plan of making an entero-anastomosis between the two limbs of the loop of jejunum united to the stomach should be followed. A small stoma (large enough to admit a finger) is sufficient, and should be placed not higher than 2 inches above the duodeno-jejunal flexure (fig. 79).

Anterior gastro-jejunostomy has a number of disadvantages: The long loop of jejunum that is joined to the stomach may compress the colon or may itself be compressed; when the operation is per-

formed for the cure of peptic ulcer, jejunal ulceration is more frequent than after the posterior operation; when undertaken for irremovable cancer of the pylorus it affords poor drainage of the obstructed stomach and less relief of symptoms than Devine's partial gastric exclusion and rarely prolongs life for more than a few weeks, and unless an entero-anastomosis is added, vicious-circle vomiting is

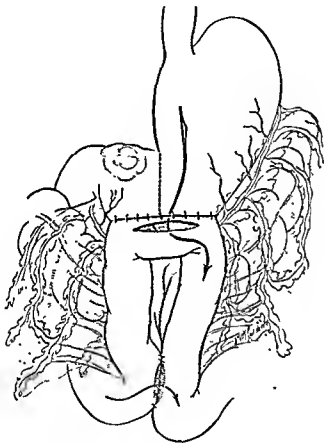


FIG. 79.—ANTERIOR GASTRO-JEJUNOSTOMY WITH ENTERO-ANASTOMOSIS.

more likely to ensue. The anterior operation is only justifiable therefore when for reasons already enumerated the posterior one is impracticable.

Retro-colic gastro-jejunostomy by the trans-gastro-colic approach is associated with the names of many famous surgeons including Brenner, Stiles, Sherren and Wilkie. In recent years Wilkie did much to popularise the method. It may be indicated in obese patients and

in those in whom the stomach is small and relatively fixed at its normal anatomical points of attachment. In such cases it is easier to bring the mobile jejunum to the stomach than vice versa. The posterior wall of the stomach is exposed through the gastro-colic omentum, either above or below the vascular epiploic arch, and the proximal jejunum is brought up through an ample opening in the mesocolon to the greater curvature or to the posterior gastric wall rather than drawing the posterior gastric wall forcibly through the mesocolon (fig. 80).

After the routine abdominal examination has been conducted and it is decided that the case requires gastro-jejunostomy and that for the reasons indicated this method would appear to offer definite advantages, the gastro-colic omentum is picked up at an avascular point, 1 inch or so below the greater curvature and in line with the incisura, and is opened at this point (fig. 80). The omentum here is thin and diaphanous, and the incision, which is readily enlarged by stretching with the fingers, gives free access to the lesser sac so that through it the whole of the posterior surface of the stomach can be methodically explored and freed from adhesions when these are present. In most cases, however, I prefer to detach the vascular epiploic arch (without damage to the main blood vessels) from a wide area of the greater curvature and to use some 4 inches of the greater curvature itself for the anastomosis with the jejunum (fig. 81).

By the posterior method a transverse fold of stomach, 1 to 1½ inches from the greater curvature and opposite to the incisura, is picked up with two pairs of Allis forceps which are placed 4 inches apart. The transverse colon is then held up by an assistant and an opening 3 inches long is made in the mesocolon through a bloodless area to the left of the middle colic artery. Through this opening a coil of proximal jejunum is drawn and carried upward (without tension and leaving a slight loop) to the site in the stomach selected for the anastomosis.

The operative field is packed off and the anastomosis carried out without the aid of clamps in the manner already described.

Finally the anastomosis is drawn through the wound in the mesocolon and its margins are stitched to the stomach wall above the suture line, after which the opening in the gastro-colic omentum is closed. The operation, when completed, will be a posterior transverse



FIG. 80.—RETRO-COLIC GASTRO-JEJUNOSTOMY BY THE TRANS-GASTRO COLIC OMENTUM APPROACH.

anti-peristaltic gastro-jejunostomy with the stoma precisely at the greater curvature or about 1 inch posterior to it (fig. 81 [inset]).



FIG. 81.—RETRO-COLIC GASTRO-JEJUNOSTOMY BY THE TRANS-GASTRO-COLIC OMENTUM APPROACH.

Note that in this operation the vascular epiploic arch is partially detached from the greater curvature of the stomach.

The main advantages claimed in connection with this operation may be briefly stated as follows:

1. The free opening in the gastro-colic omentum enables the whole of the posterior surface of the stomach to be carefully examined, and

also it greatly facilitates the separation of adhesions when these happen to be present.

2. The making of the anastomosis is a simple matter, as all traction on the stomach is avoided and the more mobile organ, *i.e.*, the jejunum, is brought up to the comparatively immobile organ, the stomach, instead of vice versa.

3. The absence of pulling on the viscera diminishes shock.

4. In patients who are fat and where the stomach is retracted, an operation which would otherwise present considerable difficulties is rendered simple and straightforward.

Stiles and Sherren prefer to attach the jejunum in an iso-peristaltic direction, and select a longitudinal fold on the anterior wall of the stomach, close to and parallel with the greater curvature. Wilkie almost invariably chose the posterior method, and Ivor Baek (*Lancet*, 2:802, 1933), in recording his results, speaks very favourably of the measure of success he has obtained by the posterior operation and offers many valuable suggestions with regard to technical details.

The causes of unsatisfactory results following gastro-jejunostomy may be summarised as follows:

1. Faulty pre-operative treatment:

(a) Failure to eradicate all accessible foci of infection.

(b) Omitting to treat chronic gastritis or chronic duodenitis when it is present to any marked degree.

(c) Not resorting to such pre-operative measures as aspiration and irrigation of the stomach and prescribing the special diet and medicine required in cases of dilatation of the stomach

(d) Failure to investigate the chemistry of the blood or to correct any alkalosis which may be present.

2. Faulty selection of cases for operation.

3. Undertaking gastro-jejunostomy for disorders other than those of chronic gastric ulcer or chronic duodenal ulcer, *e.g.*, gastropnoia, the gastric crisis of tabes, etc.

4. Lack of anatomical knowledge. There are cases on record where the stomach has been anastomosed to the transverse colon or to the ileum. Kogut and Stein (*Am. J. Surg.*, 33:263, 1936) reported 16 cases of gastro-ileostomy with the coincidental findings of gastro-ileal ulcer in 3 and gastro-ileitis in 1. Rivers and Wilbur (*Surg., Gynec. & Obst.*, 54:937, 1932) reported a series of 9 cases of gastro-ileostomy,

all proved by X-ray examination or by operation. Exploration and disconnection, with or without further treatment of the original ulcer, was performed in all but one case.

5. Errors in operative technique or mechanical causes:

(a) Failure to excise, cauterise or otherwise destroy a chronic gastric or chronic duodenal ulcer where this is possible.

(b) Failure to remove an intra-abdominal septic focus when present, e.g., chronically inflamed appendix or gall-bladder.

(c) Performing the operation with a jejunal loop which is either: too long; too short; or rotated on its long axis. Any of these errors may predispose to regurgitant vomiting.

(d) A badly planned opening. This may be: too small; too high; too large; not close enough to the greater curvature; made to the distal gastric pouch in cases of hour-glass stomach; made with a junction which is too short; or carelessly sutured.

(e) An opening in the mesocolon which is: too small; left unsutured; stitched to the jejunum or line of anastomosis and not to the stomach as recommended; sutured to the stomach in such a way that the margins are not inverted; carried too close to the colon; or narrowed by the formation of a large hæmatoma which has resulted from one of the blood vessels being punctured during the process of suturing the stomach to the margins of the mesocolon.

(f) Adhesions which result from: not peritonising the raw surfaces which remain after the jejunum has been separated from the mesocolon on account of physiological or pathological fusion; infection; the efferent loop of the jejunum becoming stuck to the abdominal scar; or the use of irritant lotions, predisposing to plastic peritonitis.

(g) Faulty methods of suturing; the use of thick non-absorbable suture material, making the anastomosis throughout with interrupted sutures; tying large knots; or drawing the sutures so tight that the tissues are strangled.

(h) Faulty use of clamps, e.g., applying them too firmly.

(i) Failing to detect duodenal ileus when present.

6. Faulty post-operative management.

7. The late development of *anæmia*, gastro-jejunitis, jejunitis (Shanks; *Brit. J. Radiol.*, 9:559, 1936), jejunal ulceration, carcinoma, or retrograde jejuno-gastric intussusception.

CHAPTER 12

HOURL-GLASS STOMACH

In hour-glass contraction the stomach is partitioned off into two compartments and very rarely three or more. The stricture or strictures which are responsible for this subdivision of the stomach may occur at any point between the cardiac and pyloric orifices.

ÆTIOLOGY AND PATHIOLOGY

The causes of hour-glass contraction of the stomach are congenital and acquired:

(a) Intrinsic causes. These are due to intrinsic ulcerative processes and include: (i) chronic gastric ulcer (over 90 per cent); (ii) gastric cancer; (iii) gastric syphilis; (iv) large stomal ulcer; (v) stenosis resulting from corrosive poisoning.

(b) Extrinsic causes: (i) perigastric adhesions from any cause; (ii) pressure from a colon distended with gas; (iii) spasmodic hour-glass constriction due to reflex causes such as chronic appendicitis.

Some of the early writers considered that hour-glass constriction was a true congenital anomaly and cited cases of bilocular stomach which had been observed in infants. Moynihan (*Brit. M. J.*, 1:413, 1904) was one of the first surgeons to discredit the congenital theory, and he showed that there was always evidence of pre-existent disease of the stomach in these infantile cases.

The following account only concerns hour-glass stomach when produced by chronic gastric ulcer.

This complication occurs in from 6 to 10 per cent of all chronic gastric ulcer cases. Walton, Hurst and Stewart place the incidence at 9.8 per cent. In 173 cases of chronic gastric ulcer investigated by Stewart at Leeds there were 17 cases of hour-glass stomach. Moynihan's figures are very similar, showing 7.8 per cent of the gastric ulcers operated upon by him; while the Mayo Clinic estimates that the incidence is 6 per cent.

In a combined series of 335 cases, no fewer than 90 per cent were women. Sherren (1923) found that of 96 cases of hour-glass stomach operated upon by him 88 were women, while Walton (1928) had only one male patient in a consecutive series of 59 cases. Balfour (1935) stated that the ratio of gastric ulcer to hour-glass deformity is 44:1 among women and 39:1 among men, and that at present there is no reasonable explanation for this disproportionate sex incidence.

In the majority of cases there is a long history of dyspepsia, dating back for many years. The complication is most commonly seen between the ages of 55 and 75, showing a maximum incidence at about the age of 65. Although occasional cases have been reported under the age of 20, and even in infants, hour-glass constriction rarely occurs in patients under 30.

The development of hour-glass stomach depends upon the size, the position, the form and the chronicity of the ulcer, the so-called saddle-shaped ulcer often being a precursor. The complication is nearly always single and is often situated in the region of the incisura, *i.e.*, nearer the pyloric than the cardiac end of the stomach, which is frequently J-shaped (fig. 82). The cardiac loculus will therefore often be found to be larger than the pyloric pouch. Pyloric obstruction due to a cicatrizing duodenal ulcer is found in 25 per cent of cases of hour-glass stomach, and when these two complications co-exist the distal pouch, *i.e.*, the pyloric, may be enormously distended, while the proximal pouch may be quite small. The ring-like constriction may take years to develop when situated in the body of the stomach, the gastric curvature being gradually drawn toward the lesser as the ulcer heals and as the fibrous scar tissue slowly contracts. In long-standing cases, and particularly where the ulcer is active, it will be found that the stomach undergoes considerable rotation on its transverse axis. The lesser curvature becomes shortened and is drawn into a posterior position, while the greater curvature is displaced upward and lies in a more anterior position, *i.e.*, against the parietal peritoneum.

Hurst and Stewart have shown that in fully 50 per cent of cases the ulcer is completely healed by the time the patient is referred to the surgeon for operative interference. In one series of 17 autopsies on cases of hour-glass stomach, Stewart found 9 healed ulcers and 8

still active, while in another series of 35 cases the ulcer had entirely cicatrized in 16.

The channel connecting the two loculi may be very small, admitting only a probe, or it may be large enough to admit one or two



FIG. 82.—HOUR-GLASS STOMACH.

At operation a large saddle-shaped ulcer was found. Partial gastrectomy was performed (McKenny).

fingers with ease. The position and the diameter of the isthmus will determine the severity of the symptoms. In many of the cases hypertrophy of the proximal pouch will occur as a result of the stenosis, but this is not usually marked except in the more acute types of

obstruction. In due course this pouch will dilate, increase considerably in size, and may even sag over the isthmus and lower segment. Perforation and hæmorrhage are very rare complications, while "so far as I know, no case of malignant degeneration of a chronic gastric ulcer associated with hour-glass contraction has ever been recorded" (Hurst, 1929).

SYMPTOMS AND SIGNS

The past history of a patient with hour-glass constriction will at once suggest that there has been a chronic gastric ulcer present for many years, but that at a certain stage in the history the symptoms have changed as a result of the stenosis which has supervened. The early symptoms are marked by variable periods of indigestion alternating with periods of complete freedom. At a later stage the periods of indigestion are more prolonged and the periods of freedom are shorter, until the symptoms recur every day and after every meal without any intermissions. If therefore a patient gives a past history of chronic gastric ulcer in which the typical periodicity is lost and the attacks become progressively longer until they are continuous, it is probable that an hour-glass contraction or a cancer of the stomach is present; in fact it is frequently impossible to distinguish between hour-glass contraction and carcinoma of the stomach without the aid of X-rays.

At the onset the pain arises $\frac{1}{2}$ to $1\frac{1}{2}$ hours after meals, but as the constriction tightens and obstruction supervenes it will be felt shortly after the ingestion of food. In an early case the taking of solid food may afford some relief, but later on the pain becomes more or less constant and is aggravated by food. The patient will eventually be obliged to eschew solid food altogether and take small quantities of liquid nourishment at frequent intervals to maintain nutrition. Pain is relieved by vomiting and gastric lavage, and to a lesser extent by alkaline draughts. When the ulcer is attached to or actually penetrates into the pancreas, there will be a stabbing pain in the back and through to the left shoulder region. In a patient giving a history of gastric ulcer this radiation of pain to the back and to the shoulder is pathognomonic of pancreatic, diaphragmatic or hepatic erosion.

On palpation there may be some tenderness in the middle of the

epigastrium or to the left of this over the upper part of the left rectus muscle. The muscle may be taut, and on deep pressure visceral tenderness may be acute while in thin patients a tumour, if present, may even be felt.

The position of the stomach and the size of the isthmus will influence the degree of vomiting. The nearer the blockage is to the cardia, the worse the vomiting will be; in fact in some of these cases the marked emaciation, dysphagia, and even regurgitation of recently ingested food will suggest a diagnosis of cancer of the œsophagus. In a typical case vomiting is absent in the early stages, but as the communicating channel progressively narrows vomiting ensues and becomes increasingly frequent. Loss of weight is often pronounced owing to the vomiting as well as to anorexia, enforced dieting, constant pain and insomnia. The majority of these patients are pale, frail emaciated women who have been chronic invalids for many years; yet, following surgical measures directed to the cure of their condition, many of them show surprising vitality and wonderful recuperative powers.

TREATMENT

In certain rare cases where there is X-ray evidence that the ulcer has healed, where the patient is not losing weight, and especially where vomiting is an infrequent symptom and can be effectively controlled by gastric lavage, dieting and medicine, and where the isthmus is large enough to admit the passage of solid food, medical measures may be persevered with for an indefinite period; but in the majority of cases surgical interference is clearly indicated after a preliminary course of pre-operative treatment conducted on the lines suggested for organic pyloric stenosis.

OPERATIONS

A large number of operations have been practised for hour-glass stomach. Many are ingenious, but the majority, although affording temporary relief, are very disappointing so far as the late results are concerned. The relative merits of the following operations will now be reviewed:

1. **Gastro-Jejunostomy:**
 - (a) Single
 - (b) Double. } anterior or posterior.
2. **Gastroplasty:**
 - (a) Heineke-Mikulicz
 - (b) Kammerer.
3. **V-Excision of the Ulcer plus Posterior Transverse Gastro-Jejunostomy plus Pyloric Occlusion—Walton.**
4. **Sleeve Resection.**
5. **Gastro-Gastrostomy.**
6. **Partial Gastrectomy:**
 - (a) Billroth I methods.
 - (b) Anterior and posterior Polya methods.

Single Gastro-Jejunostomy. Even for those cases in which this operation would appear to be particularly indicated, the late results are bad in over 50 per cent. Single gastro-jejunostomy was at one time recommended for those cases in which at operation the constriction was found in the antrum associated with a small pyloric pouch and a large proximal or cardiac pouch. It was hoped that by anastomosing the proximal pouch to the jejunum, obstruction would be overcome and that good gastric function would be restored; but this was not found to be so in fully half of the cases which were subsequently reviewed.

I consider that this operation is definitely contra-indicated in the treatment of hour-glass stomach for the following reasons:

1. Pyloric peptic ulcers are treacherous lesions in that they frequently undergo malignant change.

2. On exploration it is often impossible to distinguish a benign pyloric lesion from a cancerous one, and ulcerating pyloric lesions are often primarily malignant.

3. The operative mortality of gastro-jejunostomy is almost as high as that of partial gastrectomy for hour-glass constriction. This is not to be wondered at as a short-circuiting operation is often one of considerable difficulty. The causative ulcer may be welded to the pancreas, adhesions may be extensive and the fixed cardiac pouch may be difficult to approximate to the jejunal loop without tension.

4. Pyloric stenosis is a concomitant complication in one quarter

of the cases and demands a separate operation such as pyloroplasty to overcome stasis in the distal pouch. Therefore in fully 25 per cent of cases a double operative procedure will be required.

5. Gastro-jejunostomy may bring relief to some 50 per cent of these cases, but partial gastrectomy will cure over 90 per cent.

Double Gastro-Jejunostomy. In this operation of Weiss and Foote, a fairly long loop of proximal jejunum is taken and two separate anastomoses are made, the first to the cardiac pouch and the second to the pyloric pouch. This procedure, whether carried out by the anterior or by the posterior method, is most unsatisfactory and cannot be recommended as it is difficult to perform and there is a very high incidence of ultimate failures.

When the posterior operation is performed, a very large opening or two separate openings will have to be made in the mesocolon, which at a later date may contract and produce mechanical interference with the jejunal loops.

Gastroplasty. In the *Heineke-Mikulicz* operation, a 3-inch incision is made through the anterior wall and in the longitudinal axis of the stomach. The incision is carried through all the coats of the stomach from the middle of the pyloric pouch across the isthmus and well into the gastric pouch. The wound thus produced is stitched transversely by a three-tier suture. This is the operation of pyloroplasty applied to the stomach, and however successfully performed it is followed by a high percentage of recurrences, as the incision is made through scar tissue which invariably contracts.

Kammerer's operation is the application of Finney's pyloroplasty to the stomach. Here again the incision, as it approaches the lesser curvature, is made in indurated or inflammatory tissue, and constriction of the stoma frequently takes place, giving rise to recurrence of symptoms.

V-Excision of Ulcer plus Posterior Transverse Gastro-Jejunostomy plus Pyloric Occlusion. Walton describes the essential steps of this operation as follows:

This operation brings into line the treatment of hour-glass stomach with that of any form of ulcer on the lesser curve. The ulcer itself is removed and with it the danger of perforation, hæmorrhage, or the late onset of carcinoma; while the performance of a gastro-enterostomy will overcome the tendency to ulcer formation and thus prevent a fresh ulcer arising at the site of excision.

If there be an ulcer with stenosis at the pylorus it will be embedded in the usual manner, but even if the pylorus be free it should be occluded so that every opportunity be given to the gastro-enterostomy to act in a satisfactory manner.

By making the V-excision with a widely open angle the two limbs can be made of practically any length, the one being continued up to the oesophageal opening and the other towards the pylorus. When these two limbs are approximated and sutured the hour-glass constriction will be entirely overcome and the stomach restored to its normal shape. The width of the base of the V-shaped portion removed will vary with the amount of stenosis. . . .

In the majority of cases the technique will present but little difficulty, clamps being applied proximally and distally to the ulcer and the incision being made between them in the usual way. The gastro-enterostomy will be made on the posterior surface and will be transverse, and will be so placed that the proximal half drains what was the cardiac pouch and the distal half the pyloric pouch. It will therefore have to pass along the isthmus of normal mucosa, otherwise the sutures of the line of excision will be cut. For this reason every care must be taken to preserve the normal band of mucosa at the base. In certain cases the isthmus is so narrow that a band of stomach wall sufficient to permit of the gastro-enterostomy cannot be left and under these circumstances the operation is not feasible.

In my own series of twenty-three cases there were two deaths and twenty complete cures.¹

Sleeve Resection. This is another disappointing operation. It is expeditiously performed, the operative mortality is negligible, the ulcer with its surrounding zone of fibrous tissue is thoroughly excised, the patient is protected against hæmorrhage and perforation, and on the completion of the gastro-anastomosis the stomach is ample and capacious and is restored to its original shape. Yet, in spite of this, the results both immediate and late are distinctly poor in comparison with those which follow partial gastrectomy.

Following sleeve resection there is often considerable interference with the motor function of the stomach, giving rise to troublesome and persistent symptoms. Again, recurrence of hour-glass constriction at the site of anastomosis is by no means an infrequent complication after this operation.

Gastro-Gastrostomy. This operation is indicated when partial gastrectomy is deemed inadvisable either on account of the poor general state of the patient or because there is a high-lying upper locus. In

¹ Walton, *Textbook of the Surgical Dyspepsias*, 1930. London, E. Arnold Co.

the latter condition sub-total gastrectomy is an objectionable procedure because the operative mortality is high, and in those who survive this extensive resection, although obstruction is satisfactorily overcome and symptoms are relieved, the return to full health is often tardy in the extreme.

Hurst and Stewart write enthusiastically about this operation:

In my experience gastro-gastrostomy, which is the simplest and most rational of the operations which have been devised for hour-glass stomach, is uniformly successful. I have had some twenty-five cases operated upon, mostly by R. P. Rowlands and L. Bromley, without a single death. In every case complete freedom from symptoms followed, and, so far as I know, there has been no recurrence, although the operation was performed in the earliest cases as long as eighteen years ago. In several instances the patients were emaciated and very feeble, and symptoms had been present for twenty or thirty years. In almost all the ulcer was still active and it was often very large.

Convalescence is generally very rapid, and there has been no complication of any kind, except in one case in which moderately severe hæmorrhage occurred the day after the operation. The few cases, in which a gastro-jejunostomy had to be simultaneously performed in order to drain the lower segment of the hour glass stomach on account of the coexistence of pyloric obstruction, have done equally well. . . .

Moreover, a well-performed gastro-gastrostomy leaves the patient with a stomach of normal size and normal function, as I have often observed with the aid of the X-rays and fractional test-meal after operation; nothing passes through the old narrow channel, and the ulcer, however large and chronic it may have been, rapidly heals, as shown by the disappearance of occult blood from the stools.²

Rowlands (*Brit. M. J.*, 2:50, 1931), in his notable contributions to this subject, describes the results of this operation in his hands as being entirely satisfactory. Patterson, however, found that the late results were disappointing in about 30 per cent of his cases, while the Mayo Clinic figures show 23 per cent of failures following this operation.

I would regard gastro-gastrostomy as a good alternative to partial gastrectomy for hour-glass stomach. It is simple to perform and has a low mortality—about 2 per cent.

After the stomach has been sufficiently mobilised, the gastro-anastomosis is carried out without the aid of clamps. A pair of Allis forceps is clipped to the lesser curvature and one pair directly opposite on

² Hurst and Stewart, *Gastric and Duodenal Ulcer*, 1929. London, Oxford University Press.

the greater curvature of the pyloric pouch some 2 inches or so from the isthmus, so that when these forceps are elevated the vertical fold on the anterior wall of the stomach from the lower loculus can be brought across the ring constriction and laid by the side of the vertical fold from the upper loculus, which is also steadied with Allis forceps applied in a similar manner.

The opening between the two pouches must be large and there must be no tension on the suture line when the anastomosis is completed. The suturing itself is conducted as in the operation of gastro-jejunosomy with the exception that the first continuous seromuscular suture is made with silk instead of with No. 0 twenty-day chromic catgut.

Partial Gastrectomy. This is the operation of choice for hour-glass stomach, and should be performed in every case except where the general and local conditions are unfavourable.

With increasing experience the operation is a feasible and justifiable procedure, even in aged patients, being associated with a death-rate no higher than that which follows gastro-gastrostomy. In a personal series of 14 cases there were no operative deaths, and one of the patients was a frail and emaciated woman of 80 years of age who had pyloric stenosis due to a stenosing duodenal ulcer in addition to an extreme degree of mid-gastric constriction caused by a chronic gastric ulcer which had produced symptoms for over fifty years. A partial gastro-duodenal resection was performed and the gastro-intestinal continuity was restored by the posterior Polya method. She is at the present date in perfect health, attending to her daily household duties and has gained 2 stones (28 pounds) in weight since her operation two years ago.

My experience has been that partial gastrectomy is a comparatively easy and straightforward undertaking in most cases of hour-glass stomach for these reasons:

1. The patients are all thin.
2. The ulcer is healed in fully half the cases, is often loosely attached posteriorly, and the stomach is always of the J-shaped, ptosed variety which permits of a free mobilisation.
3. When the ulcer is perforating the pancreas, the stomach can be cut adrift from it and the resection will then present no special difficulties.

4. The operation can be conducted leisurely under local anæsthesia, thus reducing visceral shock and the incidence of post-operative pulmonary complications.

There is little to choose between the Billroth I types of repair and the Polya methods, but I am partial to the Finochietto plan and to the posterior Polya operation.

CHAPTER 13

ACUTE PERFORATION OF GASTRIC AND DUODENAL ULCERS

In acute perforation a sudden rupture of the base of a gastric or duodenal ulcer takes place, with the result that the contents of the stomach or duodenum are thereupon free to escape into the general peritoneal cavity.

It is the most important complication of peptic ulcer and is estimated by most authors to occur in about 10 to 15 per cent of cases of chronic gastric and duodenal ulcer. Raven (*Post-Grad. Med. J.*, 12:470, 1936), however, found the incidence to be 27 per cent in a large series of cases investigated by him. He agrees with Pyrali, Hinton, Joll, Shawan and others, that since medical treatment has become "systematised" there has been a marked rise in the incidence of perforation as a complication of peptic ulcer. Raven considers that the medical treatment of peptic ulceration carries a considerable mortality as the result of perforation and, to a lesser degree, of hæmorrhage, and he proves this in his series of 222 cases of gastric ulcer which were treated medically with a mortality of 6.5 per cent, while in a series of 132 cases of duodenal ulcer the death-rate was 5.3 per cent. Flint (*Lancet*, 2:1973, 1937) attributes the increased incidence of perforation in patients of the so-called hospital class in Leeds to economic and dietetic reasons. Shawan's figures (*Am. J. Surg.*, 40:70, 1938) are very convincing; he shows that there were only 10 cases of perforated peptic ulcer operated upon at the Receiving Hospital of Detroit in 1923. In 1927 there were 17 cases, and in 1930 there were 24 cases, while in 1936 there were no fewer than 50.

Perforation is the most common cause of death in ulcer cases:

This is well seen from the statistics relating to 500 consecutive cases of chronic ulcer found post mortem at the Leeds General Infirmary. Out of 96 cases in which death was attributable to a gastric ulcer, 62 (64.5%) followed acute and 6 sub-acute perforation; out of 200 cases in which death resulted from duodenal ulcer, 170 (85%) followed acute and 5 (2.5%) sub-acute perforation.¹

¹ Hurst and Stewart, *Gastric and Duodenal Ulcer*, 1929 London, Oxford University Press.

SOME ETIOLOGICAL FACTORS

1. **Sex Incidence.** When a large series of cases is studied, the striking fact emerges that there is a preponderance of men over women. The usual proportion of men to women is 20:1. In a collected series of 757 cases there were 723 men and only 34 women. In Shawan's series of 389 cases, all but 7 occurred in men, while in Roscoe Graham's smaller series of 51 cases, there were 46 men and 5 women.

2. **Age Incidence.** By decades, the 30-40 age period shows by far the largest number of cases, the 40-50 being next. Perforation is rare before 20 and after 60, its highest incidence probably being about the age of 37. Perforation may, however, occur in an infant of a few days or in extreme old age. Stern, Nessa and Perkin (*Journal-Lancet*, 49:492, 1929) described a perforated gastric ulcer in a child of two days, and Corff states that other cases of perforation have been reported in an infant of two weeks of age and in another of two months. Graham (*Surg., Gynec. & Obst.*, 62:235, 1937) reported a case of perforation in a man of 82 who survived the operation of simple suture.

3. **Occupational Incidence.** It is commonly stated that acute perforation is more likely to occur in those engaged in heavy manual work, and that the lifting of weights and the like, or strenuous exercises, by causing a rise of intra-abdominal pressure, predisposes the patient who is suffering from a peptic ulcer to perforation. This, however, was not the experience of Tilton (*Am. J. Surg.*, 32:238, 1936) who in analysing 50 cases in which the occupation was given found that 33 were of the sedentary class, including clerks, bookkeepers, telegraph operators, etc. In his series there were only 17 whose work could be described as strenuous, such as porters, dock labourers, etc.

4. **Trauma.** It is well known that a blow in the epigastrium may precipitate perforation. Shawan, in drawing from his wide experience, states that in his series of 389 cases eight patients gave a definite history of trauma which was apparently responsible for the perforation. One patient had a sack of cement fall upon his abdomen, another was hit by a moving belt, and others were struck by various objects.

5. **Seasonal Incidence.** Many writers have sought to prove that there is an increase in ulcer symptoms and in ulcer perforation in the spring and in the autumn, when changeable weather is so frequently encountered. Sallick (*Ann. Surg.*, 104:853, 1936), however, in analysing his cases, found no significant variation between the months, and this is in accord with most of the recent views expressed on this point.

TYPES OF PERFORATION

Three types of perforation are described:

1. **Acute.** Here the ulcer perforates and the general peritoneal cavity becomes flooded with gastric contents.

2. **Sub-acute.** In sub-acute perforation only a circumscribed area of the peritoneal cavity becomes contaminated by the leakage. Such localisation may be dependent upon a number of factors, such as the very limited size of the perforation, the stomach being empty, adhesions being present near the ulcer, or the plugging or sealing off of the opening shortly after perforation, either by an adjacent portion of omentum, a neighbouring viscus, flakes of lymph, a particle of food, or a protrusion of the mucous membrane through the rent. An account of sub-acute peptic ulcer perforation is given on page 397.

3. **Chronic.** Here the ulcer has penetrated a neighbouring viscus such as the pancreas, and the base of the crater is no longer formed by the stomach but by the structure which has been eroded. Sometimes as the result of a very slow leak a localised abscess may develop in the vicinity of the ulcer—peri-gastric abscess, or rarely a posterior penetrating ulcer may perforate into the lesser sac and give rise to one of the varieties of sub-phrenic abscess. The management of these cases is described on page 206.

The description which now follows relates only to the *acute* variety of perforation.

PATHOLOGY

The average ratio of duodenal ulcer to gastric ulcer perforations, as reported by most clinics in Britain and America, is about 5 : 1. In support of this statement the following representative figures may be quoted: Eliason and Ebeling (*Am. J. Surg.*, 24:63, 1934) showed 60 duodenal and 14 gastric ulcer perforations in their series of 74 cases,

while in Corff's series of 63 cases there were 52 duodenal and 11 gastric perforations.

Acute perforation may occur in an acute or chronic ulcer, and the accepted opinion is that in over 90 per cent of cases the ulcer that perforates is of the chronic variety. Girling Ball reported the autopsy findings in a series of 34 cases in which there was only one example of an acute ulcer. Walton (*Lancet*, 2:269, 1922) found that of 79 cases of perforated gastric or duodenal ulcer which were fatal, 78 were seen on post-mortem examination to have ulcers of the chronic variety. Moynihan writes as follows:

Acute perforation

affects chronic ulcers far more frequently than acute ulcer. It is necessary to be precise upon this point, for the literature of this subject contains many inaccurate assertions that perforation occurs in acute rather than in chronic ulcers. In twelve consecutive years at Leeds Infirmary (1910-1921) there were 61 deaths from perforation of a gastric ulcer; in 60 cases the ulcer was of the chronic variety. There were 117 deaths from perforation of a duodenal ulcer. In 12 of these cases there was an acute ulcer; in 4 of the 12 there was a chronic ulcer also, and it was in every case the chronic ulcer which had perforated. In 8 cases an acute ulcer had perforated.*

It is, in my opinion, impossible to determine during the conduct of operation whether the ulcer which has perforated is actually acute or chronic, as, even in the case of acute ulcers, there is always a swollen and stiffened area to be found around the margins. If perforation of acute ulcers were a common occurrence, simple suture is all that would be necessary to effect a permanent cure in all such cases; it is well known, however, that a large number of patients treated by this method experience subsequent trouble which calls for a course of medical treatment or further operative measures. Fully 95 per cent of peptic ulcers which perforate into the general peritoneal cavity are situated on the anterior or antero-superior wall of the stomach or duodenum. The site of the ulcer is obvious in the majority of cases. It is either gastric or duodenal. Such terms as "pre-pyloric," "post-pyloric" and "juxta-pyloric" are all very confusing and vitiate statistical figures. A pyloric or pre-pyloric ulcer is, presumably, a gastric ulcer, while a juxta-pyloric ulcer may be either a gastric or a duodenal ulcer. Such vague nomenclatures find no place in exact

* Moynihan, *Addresses on Surgical Subjects*, 1923.

surgical science. It is, nevertheless, true in some cases, and these comprise a small minority, that the anatomy of the pylorus and of the duodenal bulb may be greatly distorted and disfigured as the result of the ulcerative process, that the veins of Mayo which mark the dividing line between the stomach and duodenum may be obliterated by scar tissue or dense adhesions, and that the involved portion of gut may be so obscured by tenacious lymph and anomalous vascular membranes that it may, in fact, be difficult to determine at sight whether the perforated ulcer lies to the right or to the left of the swollen pyloric ring.

By invaginating the anterior wall of the stomach so that the finger abuts against the ring of the pylorus it should be possible to determine with a fair degree of accuracy whether the perforation lies in the stomach or in the intestine below. The surgeon should also remember that pyloric peptic ulcers are very rare, while duodenal ulcers are common, and that in cases of genuine doubt it is wiser to classify such perforations as duodenal rather than as gastric.

As I have stated, fully 95 of every 100 cases of chronic duodenal ulcer which perforate are situated in the first portion of the duodenum on the anterior or superior surface, and that of the remaining five cases, four ulcers will be found on the posterior wall and only one on the anterior wall of the second portion of the duodenum.

Posterior ulcers which so often deeply penetrate into the substance of the pancreas can only perforate when the ulcer spreads and burrows its way toward the superior or inferior surface of the duodenum. The small and slit-like character of the perforation renders it most difficult to locate and suture at operation.

Owing to the small size of the opening and to the fixation of the gut to the pancreas or to an adjacent viscus, a localised intra-peritoneal abscess—sub-phrenic abscess—is more likely to occur than a diffuse contamination of the peritoneal cavity. These posteriorly situated ulcers may perforate extraperitoneally and the extravasated fluid gradually collect in the region around the right kidney and give rise to signs of a perinephric abscess. The duodenal contents may also travel still further downward, tracking beneath the peritoneum toward the right iliac fossa and produce a swelling here which may be indistinguishable from that of an appendiceal abscess. When such

abscesses are drained, an external duodenal fistula results (see pages 944, ff.).

Grey Turner has called attention to the type of case presenting two ulcers, a chronic posterior wall ulcer and an acute perforated "contact" ulcer immediately opposite in the anterior wall.

The size of a perforated duodenal ulcer varies from $\frac{1}{8}$ to $\frac{3}{8}$ of an inch, and is generally smaller than a gastric ulcer. The majority of perforated ulcers of the stomach are found on the anterior or antero-superior surface of the lesser curvature in the region of the incisura or slightly above this somewhere in the region of the vertical portion of the lesser curvature. It is most exceptional to find a perforated ulcer near the cardia, but perforations in this position present great difficulty in suturing and may even be overlooked.

The callous ulcer which is situated in the region of the greater curvature, whether perforated or not, is probably carcinomatous and calls for radical measures whenever possible.

Posterior ulcers of the stomach usually perforate superiorly at a point where they are not attached to the pancreas, *i.e.*, in the region of the lesser curvature. Perforation may take place into the lesser sac or even between the layers of the gastrohepatic omentum. Multiple perforations occurring simultaneously have been described, but they are very rare. In spite of this, after the surgeon has dealt successfully with one perforation he should examine the whole stomach and duodenum and make a rapid but methodical search for any other perforation which may be present. Multiple gastric perforations are usually found close together, and I have had two instances of this. It is more common to find that the base of one large chronic ulcer has perforated at two separate points than that two separate ulcers have perforated simultaneously. It is exceptional to find a chronic gastric ulcer in association with a perforated duodenal ulcer, and vice versa. In females, a perforated duodenal ulcer is commoner than a perforated gastric ulcer, although many writers have stated that the reverse is the case.

The larger the perforation, the higher the mortality. Gastric ulcer perforations are usually considerably larger than duodenal ulcer perforations. Consequently, the prognosis is always more grave and the mortality higher with these gastric cases. The aperture is round, oval or slit-like, and varies in size in individual cases. It may be a minute

puncture, such as might be produced by a pinprick, but it is frequently from $\frac{1}{8}$ to $\frac{3}{4}$ of an inch in diameter. Perforations with a diameter of more than 1 inch have been reported.

Perforation is a rapid process, even in chronic ulcers, and is due to the sudden sloughing of an unsupported portion of the floor of the ulcer secondary to a slow progressive process of devascularisation. Immediately after the perforation has occurred, chemical peritonitis develops as a result of the irritant action of the contents of the stomach or duodenum. It is difficult to determine how long it takes for this simple irritative peritonitis to develop into a frank septic peritonitis—the result of the invasion of the peritoneal cavity by pyogenic organisms. This depends upon many factors, such as the size of the perforation, the reaction and composition of the gastric or duodenal contents, the partial or complete flooding of the peritoneal cavity, the general condition of the patient, and his resistance to infection.

When gastric contents, neutral or alkaline in nature from secondary gastritis or from the ingestion of alkaline drugs prior to perforation, are free to escape through an opening in the stomach, the onset of a virulent septic peritonitis can only be delayed for a few hours. When, however, the escaped gastric juice is strongly acid and therefore actively bactericidal, the infection is considerably inhibited.

In the average case it may safely be assumed that during the first twelve hours the peritonitis is non-infective. Where, however, a perforation has existed for more than twelve hours, the peritoneal fluid will be infective in character.

Intestinal obstruction ensues about thirty-six to forty-eight hours after perforation has occurred, and culminates in death—usually about seventy-two hours later. This stage represents the paralytic stage of general peritonitis and is clinically similar to the final stages of intestinal obstruction from other causes. The amount and the nature of the fluid in the peritoneal cavity will have an important bearing upon the prognosis, as the more fluid there is, and particularly if this fluid is thick and contains particles of food, the worse the outlook and the higher the mortality.

When large accumulations of fluid are found, the intestines, through being partly submerged in this turbid, irritating substance, are unable to form defensive adhesions or to limit the spread of the contamination. When the perforation is small and the stomach is

empty, the patient is more fortunate in that a localised abscess may form. When pus tracks upward toward the diaphragm, a sub-phrenic abscess develops, whereas when it becomes shut off in the pelvis a localised pelvic abscess results.

SYMPTOMS AND SIGNS

The transition from normal health, that is, from the moment before perforation actually occurs, to the moribund stage associated with the Hippocratic facies, is a gradual one, but it is, nevertheless, possible to divide this downward progress into five stages. In these the pathological processes and corresponding clinical pictures inevitably tend to overlap:

1. The moment of perforation.
2. The stage of chemical peritonitis.
3. The stage of reaction.
4. The stage of bacterial peritonitis.
5. The stage of intestinal obstruction.

About 85 per cent of patients give a long history suggestive of gastric or duodenal ulcer, 5 per cent give a short history of gastro-intestinal upset, while approximately 10 per cent give no history of previous disturbance, their first symptom being perforation.

In the study of a large series of cases it is surprising to find that not more than 20 per cent of the cases which perforate have had a well-supervised systematic course of medical treatment. Perforation is rare where the patient is undergoing strict medical treatment in hospital, but when it does occur it is of the most lethal form, as Vale and Cameron (*Ann. Surg.*, 103:353, 1936) have shown. An acute exacerbation of the symptoms is found in 25 per cent of cases before perforation occurs. Although the partaking of a large meal, straining, coughing, strenuous exercise, or trauma to the epigastrium may be influencing factors in precipitating perforation, on the other hand, rupture may occur while the patient is resting or even asleep.

The clinical picture is unmistakable. At the *moment of perforation* the patient is suddenly seized with an acute agonising upper abdominal pain, which rapidly becomes generalised but is of a more intense, lancinating character in the epigastrium over the site of the rupture. In some cases where the perforation is small and leakage

intermittent, the pain may be more marked on the right side when the ulcer is duodenal and on the left when gastric. Immediately perforation occurs the patient is plunged into a state of profound collapse closely resembling true surgical shock.

But if the word "shock" is strictly interpreted it means a condition in which the blood pressure is low, the pulse fast, and the total blood volume diminished. This is not the state of patients within an hour or two of the occurrence of perforation. If we use the word "shock" to describe the appearance and not the state of a patient, then and then only can we say that the victims of a perforation suffer from "shock."*

During the stage of *chemical peritonitis* which follows sharply upon perforation, prostration or collapse is the outstanding feature. The symptoms which arise with such dramatic suddenness are due to the perforation itself and to the intense irritation of the peritoneum by the escape of gastric and duodenal contents. This sudden and violent irritation of the peritoneum produces profuse reflex effects on the circulatory and nervous systems. It may be so overwhelming as to cause immediate death or it may strike a man down and render him immobile and helpless. After an interval which may vary from two to six hours, the stage of reaction is ushered in, and this, which may last as long as six hours, gradually merges into the ominous phase of *septic peritonitis*. The pain is most intense at the moment of perforation and during the phase of chemical peritonitis, but it tends to ease off somewhat as the condition of the patient becomes more desperate.

On examination it will be seen that the patient lies almost rigid with his legs drawn up and his hands held tensely to his sides. He is afraid to move as he knows that the slightest turn in bed will aggravate the pain and increase his anguish. His face indicates the agonies he is suffering; he is anxious and blanched and his expression is one of fear, while his forehead and extremities are cold and drenched in perspiration. In the early stages after the catastrophe, nausea and vomiting are uncommon features, although retching may be troublesome. Blood is very rarely vomited after perforation has occurred, and the cataclysmic combination of perforation and severe hæmorrhage is seen in only about 1 per cent of cases.

The pain may be referred to the top of one or both shoulders. If

* Moynihan, *Abdominal Operations*, ed. 1, p. 226, 1926.

present on the right side, it would suggest a perforated duodenal ulcer; if bilateral, that a gastric ulcer situated on the lesser curvature or on the anterior wall of the stomach has ruptured into the general peritoneal cavity. This pain referred to the shoulder is caused by irritation of the diaphragm and travels through the phrenic nerve to the cutaneous distribution of the fourth cervical spinal segment. Such referred pain is also present in other conditions, notably in diaphragmatic pleurisy. It is important to enquire about this pain when the diagnosis lies between acute perforation and acute appendicitis, as it is absent in the latter condition. The clinical value of this symptom has rightly been stressed by Zachary Cope (*The Early Diagnosis of the Acute Abdomen*, 1932).

The temperature during this stage is nearly always sub-normal and may be as low as 95° to 96° F.; on the other hand, in spite of the collapse and the shock-like condition which is characteristic, the pulse rate is frequently normal, and although it may rise a few points it rarely exceeds 90. The respiratory rate is always increased, and the respiratory excursions are shallow and thoracic in nature owing to the immobility and fixation of the diaphragm—the largest abdominal muscle.

On inspection, the abdomen will be seen to be immobile, there being no movement on respiration. It is also retracted with the rectus muscles standing out in bold relief, firmly contracted, with visible muscular intersections. On palpation the muscles are tensely rigid and board-like. This rigidity is universal and extends into the flanks. On the most prolonged and searching examination, relaxation will not occur, even for a fleeting moment. When seen in the early stage, the muscle overlying the perforation itself is particularly metal-like, and the tenderness, although generalised, is more exquisite in the region of the rupture. This rigidity of the abdominal muscles arises immediately after perforation has occurred, and persists throughout this stage of chemical peritonitis which is now under discussion, through the stage of reaction, and well into the final stage of frank peritonitis, when it may lessen to some degree owing to the toxic effects in the neuro-muscular system.

The administration of morphia has the effect of numbing the pain and rendering the patient more comfortable and less apprehensive; but it has little or no direct influence upon the stubborn rigidity of

the abdominal muscles. Complete relaxation is difficult to obtain, even when a general anæsthetic has been administered.

The fluid escaping from a small perforation in the duodenum may, by trickling down "Moynihan's gutter," produce the signs of acute appendicitis. The duodenal contents issuing from the opening in the gut are thrust against the little hillock of the transverse colon and deflected downward to the lateral side of the ascending colon to the right iliac fossa where pooling of the fluid occurs with the production of signs similar to those found in many cases of acute appendicitis. In such cases as these the rigidity on the right side of the abdomen is, in the early stages, more pronounced and more obdurate than that on the left side: but it is only a question of some hours before the pelvis is flooded, and as more fluid accumulates it slowly rises and then spills over into the left iliac fossa, until eventually the whole peritoneal cavity is contaminated. The rigidity in such cases will then become generalised.

The *stage of reaction* has been called the stage of delusion, as "shock" gradually passes off and there is—to all appearances—a general improvement in the patient's condition.

This stage represents the transition period between the stage of chemical peritonitis and that of bacterial peritonitis. Pathologically, it corresponds to the very early stage of bacterial peritonitis, and on the systemic side to the gradual transition from the stage of "peritoneal shock" to that of the toxæmia of bacterial infection.⁴

The length of the stage of reaction, as I have stated, shows considerable variation, but rarely exceeds six hours. The patient will state that he feels better and that granted a little rest all will be well. Pain, although still present, is not so acute; its sharp edge is dulled. He feels warmer, and his colour and general mien improve. Sweating may still be profuse, but the extremities are now no longer chilled. The temperature slowly returns to normal, the pulse shows little if any change in rate, and the respirations remain slightly raised. He is thirsty and often asks for a drink. He feels that he has been through a terrible ordeal but that he is now well on the way to recovery. The trained eye, however, will detect that the alae nasi are working vigorously, that the respirations are still shallow, laboured, jerky, and

⁴ Payne, *St. Barth. Hosp. J.*, 45:192, 1936.

costal in type, and that the patient lies completely motionless with the knees drawn slightly upward, and is afraid to move about in bed.

An examination of the abdomen will reveal that there is something seriously amiss and that a condition consistent with some grave abdominal catastrophe is present, calling for immediate surgical measures. The abdominal wall is tensely rigid to a marked degree, and is still board-like, tender and flat. The pelvic peritoneum will be found to be exquisitely tender on rectal examination. There may be some diminution of liver dulness. If there is no abdominal distension and there is a diminution of liver dulness it may be very rightly assumed that perforation of a hollow viscus has occurred. It is best to percuss in the mid-axillary line about 3 inches above the costal border, and if distinct resonance be found here then there can be no doubt that a perforation is present (Zachary Cope). This sign is positive in only a minority of all cases. In the presence of abdominal distension it is, however, of no diagnostic value. Graham stresses that liver dulness as a diagnostic sign in cases of perforation is of little value.

However, if it be possible in a questionable case to take a flat roentgenographic plate centered on the dome of the diaphragm, gas will be shown to occupy the sub-phrenic space. This we believe is pathognomonic of perforation of a hollow viscus unless the plate be taken after operation after the patient has had a spinal anæsthetic. Dr. F. I. Lewis reported a series of cases in which an occupied the sub-phrenic space after laparotomy under spinal anæsthesia for periods varying to six weeks.⁸

Sallick has pointed out that "definite roentgenographic indication of right diaphragmatic elevation by gas is the most reliable diagnostic aid, but negative roentgenographic findings frequently occur and must be disregarded."

Shifting dulness may be detected in the flanks, and becomes more marked with the passage of time, but should not be sought for as every movement of the body produces agonising pain.

It is in this stage of reaction, when apparent recovery is taking place, when the patient is feeling better, and when the temperature and pulse are normal, that most of the errors in diagnosis occur. The abdominal physical signs, however, leave no room for doubt. The pain, tenderness and rigidity are still blatantly present, and there is

⁸ Graham, *Surg., Gynec. & Obst.*, 61 235, 1937

an aggravation of the distress if the patient sits up or turns over in bed.

The *stage of bacterial peritonitis* begins about 12 hours after perforation, and lasts for twenty-four hours or more until succeeded by the final stage of paralytic intestinal obstruction. Pathogenic organisms now freely multiply in the peritoneal cavity, the exudate becomes more abundant and more purulent, and the intestines become hyperæmic and stuck together by fibrinous exudate. With the onset of septic peritonitis the intestines slowly but progressively distend with gas and fluid, and intestinal movement diminishes and subsequently ceases altogether. Pain is present, but it is not so severe as during the first few terrible hours following the perforation. Vomiting commences and may be frequent, while hiccough may sometimes further distress the patient. Owing to profuse sweating, vomiting, and the pouring out of fluids into the peritoneal cavity, thirst becomes insatiable and the tissues become shrunken. The body is now dry and hot, the eyes bright and enquiring, and the cheeks flushed, while the lips and tongue are parched. The bounding pulse steadily rises, and toward the end of this stage it may be 100 to 110. The temperature mounts to 99° or 100° F., and the respirations are hurried.

An examination of the abdomen will show certain important differences between this and the preceding stage. Owing to the accumulation of gas and fluid in the intestines, the abdomen, which formerly was retracted, now starts to distend, and this distension steadily increases until the end. The abdominal muscles are still rigidly on guard; but although they are no longer board-like they are nevertheless tense enough to limit the distension to some degree—for the time being at any rate. Tenderness is still generalised, but the palpating hand is no longer resented. On auscultation the death-like stillness may be disturbed by an occasional tinkle or crackling sound, denoting that there is still a flicker of movement in the bloated intestines.

The *stage of intestinal obstruction* begins about thirty-six to forty-eight hours after the onset of perforation, and ends in the patient's death a day or two later. It portrays the paralytic stage of general peritonitis and is clinically identical with the final phase of acute intestinal obstruction due to other causes. The intestines become increas-

ingly distended with gas and fluid as they become progressively more paralysed. When the patient is seen with the Hippocratic facies it denotes that the end is fast approaching and that the struggle is almost over. The breath is offensive, the eyes are glistening and hollow and are surrounded by dark rings; the face is ashen-gray or mottled; the lips are purple, indicating circulatory failure; the tongue is dry and deeply fissured; sordes collect between the teeth and at the sides of the mouth; and the body is icy cold and clammy. The pulse, which formerly was full and bounding, now becomes very rapid (130-160) and small, until eventually it is thready and imperceptible at the wrist. The temperature, which may have been somewhat elevated, now falls significantly to 96° or 95° F. The respirations through a fixed and gaping mouth are very laboured and rapid. The abdomen gradually distends and becomes tense. Tenderness diminishes or may even be absent, and the rigidity which before was inflexible is now more yielding. With the advent of ileus and meteorism the movements of the intestinal tract are stilled. Flatus and feces are therefore not passed. Owing to the absence of peristaltic movements true vomiting also now comes to an end and is replaced by the effortless regurgitation of dark, evil-smelling fluid through the mouth. There may be retention of urine, or, if urine is passed, the act of micturition is difficult and painful and the urine voided is scanty and highly concentrated, loaded with albumen, and contains traces of indican.

The patient may either drift into delirium followed by coma, or may remain acutely conscious to the end. In an average case death takes place toward the end of four or five days after perforation.

DIAGNOSIS

The diagnosis presents relatively little difficulty and is correctly made in over 90 per cent of cases. In a few patients the clinical picture may be atypical, as for instance in those suffering from nervous diseases complicated by perforation. In others a diagnosis of coronary thrombosis, ptomaine poisoning, diaphragmatic pleurisy, etc., may be made, resulting in a lost opportunity of rendering timely surgical aid. Where it is impossible to make an accurate diagnosis it is just as important to recognise that an acute abdominal catastrophe is present, requiring immediate surgical interference. If the patient gives

a history of previous gastric trouble, and especially if he has been treated medically for peptic ulcer, the advent of a sudden agonising abdominal pain followed by collapse and abdominal rigidity and tenderness should leave no doubt in the mind of the clinician that the case is one of acute perforation.

The stage of reaction is still too often the stage of deception in which a wrong diagnosis is made. The surgeon should remember that during this stage the abdominal rigidity and tenderness are more marked than in the preceding stage, and he should not be influenced by the patient's assertion that the pain is passing off and that there has been a false alarm.

In the third and fourth stages the diagnosis is obvious—peritonitis and obstruction.

DIFFERENTIAL DIAGNOSIS

1. Acute Medical Conditions:

- (a) Colic: renal; biliary; intestinal; lead.
- (b) Ptomaine poisoning.
- (c) Gastric crisis of tabes.
- (d) Acute thoracic diseases: acute diaphragmatic pleurisy; lobar pneumonia; acute pericarditis; coronary thrombosis; dissecting aneurysm of the thoracic or abdominal aorta.
- (e) Acute alcoholism.
- (f) Meningitis.

2. Surgical Conditions:

- (a) Acute appendicitis.
- (b) Acute hæmorrhagic pancreatitis.
- (c) High intestinal obstruction.
- (d) Acute cholecystitis.
- (e) Mesenteric thrombosis.
- (f) Ruptured ectopic gestation.
- (g) Acute peritonitis from any cause.

The three conditions which most closely simulate acute perforated peptic ulcer are acute appendicitis, acute hæmorrhagic pancreatitis, and coronary thrombosis.

Acute Appendicitis. A diagnosis of acute appendicitis is sometimes made in cases of perforated duodenal ulcer. This is especially so when an examination is conducted shortly after perforation has occurred. As previously described, the escaping duodenal contents may in the first instance be deflected to the right iliac fossa and collecting there may mimic the clinical picture typical of acute appendicitis. Although the local signs may be those of appendicitis, a careful consideration of the history and the order in which the symptoms appeared will ensure a correct diagnosis in the majority of cases.

The onset of appendicitis is usually insidious and the initial epigastric pain is often mild in character. This is in contrast with the acute, sudden, agonising epigastric pain immediately followed by abdominal rigidity which is seen in perforation. Again, shoulder pain is very rarely felt in cases of acute appendicitis. Nevertheless, the sequence of epigastric pain, nausea, vomiting, and pain in the right iliac fossa, which may be seen shortly after perforation of a duodenal ulcer, may be sufficient in some instances to confuse the issue and lead to the removal of the appendix before the true lesion has been discovered.

Acute Hæmorrhagic Pancreatitis. This is a rare disease accounting for about 1 per cent of all abdominal emergencies. It is sometimes mistaken for a perforated peptic ulcer or a high intestinal obstruction. The patients are usually obese, past middle age, and they may give a history of previous attacks of "gall-stones" or of chronic dyspepsia.

The initial pain, which is intensely agonising and acute, is often more severe than that associated with perforation. It arises suddenly and is felt chiefly in the region of the umbilicus or in the epigastrium. It is accompanied by visceral shock. The pulse rate is always very rapid from the start (110 to 140), in contrast with the relatively slow pulse rate which obtains during the first six to twelve hours following perforation. Rigidity of the abdominal muscles is not so marked as in cases of perforation, in fact it may often be absent. In a typical case, however, muscular guarding is more pronounced in the epigastrium than it is in the lower half of the abdomen. An indefinite swelling may be made out in the epigastrium. Tenderness in this region, although present, cannot be compared to that which follows perforation. Cyanosis is present in a number of cases, and is

especially noticeable in the face and neck. This slate-blue lividity is stated to be pathognomonic of acute hæmorrhagic pancreatitis, but I have noticed the same condition in cases of perforated peptic ulcer accompanied by marked toxæmia. Vomiting is often continuous and of the obstructive type. When the stomach is empty, retching may be intractable, and this is frequently the most characteristic feature. The urinary diastase is increased ten times or more.

A diagnosis of acute perforation is often made in cases of acute hæmorrhagic pancreatitis, as the latter condition, owing to its extreme rarity, is seldom borne in mind. In such a case, if the possibility of the condition is considered, the diagnosis at once appears obvious as the clinical picture of acute hæmorrhagic pancreatitis is very striking.

Coronary Thrombosis. Coronary occlusion may be attended by marked and continuous epigastric pain, and even severe vomiting, deathly pallor, dyspnoea, a feeble pulse, and collapse associated with a falling blood pressure. Although the precordial and epigastric pain may be intensely acute, there is no muscular rigidity and no maximum point of tenderness over the abdomen, which moves well on respiration. The breathlessness, the pallor, the fall in blood pressure, and later the pericardial friction rub are perhaps the most reliable points in differentiation in the early stages.

PROGNOSIS

This will depend upon:

1. The amount and nature of the fluid in the stomach at the moment of perforation. The fuller the stomach, the worse the outlook.
2. The size of the perforation. Here again, the larger the perforation, the poorer the prognosis.
3. The position of the ulcer. The prognosis will depend partly upon the exact anatomical site of the rupture. It is best with anterior wall duodenal ulcers, and becomes progressively worse with those situated in the pyloric region, those upon the lesser curvature of the stomach, and those in the region of the cardia.
4. The type of operation performed, the skill of the operator, and the choice of anæsthetic. In most hands the mortality is lower

with simple suture than with other methods such as gastro-duodenal resection or suture combined with gastro-jejunostomy. The safest anæsthetic agents are local (novocaine), spinal (percaine), or cyclopropane.

5. The efficiency of the general practitioner and of the local transport services. Great distance from a surgical centre, necessitating a long journey, and delayed consent for operation may account for the sacrifice of many valuable hours *between the moment of perforation and the performance of the operation.*

6. The age and the general condition of the patient. The older the patient, the graver the risks. It stands to reason that patients who are in a poor state of health from any cause are graver risks than those who are young and in good condition.

7. The time factor. The time which has elapsed between the occurrence of the perforation and the performance of the operation is the most important single factor in the prognosis, as all published statistics will readily prove. The longer the interval between the rupture and the operation, the higher the death-rate. For patients who are admitted to hospital within twelve hours of perforation, the prognosis is good; but with each hour's delay the chances of recovery steadily diminish. For instance, when operation is performed within six hours of perforation, the mortality will vary from 2 to 6 per cent, within twelve hours it will be 10 to 15 per cent, within twenty-four hours it will be from 30 to 50 per cent while if operation is done within thirty-six hours it may be as high as 75 per cent. If operation is performed during the late stage of peritonitis or when obstruction is fully established, *i.e.*, after forty-eight hours, the outlook is well nigh hopeless; in fact, Tilton considers that it is probably better judgment to abstain from operation in these cases and to rely upon natural reparative processes which, in isolated instances, have been known to bring recovery. The all-round operative mortality for acute perforated peptic ulcer is about 20 to 25 per cent.

TREATMENT

Success depends not so much upon the skill of the surgeon as upon the prompt recognition of the catastrophe by the general practitioner, the pre-operative treatment of the secondary (biochemical)

manifestations of the perforation and the closure of the rupture by the most expeditious, simple and atraumatic procedure possible.

Pre-Operative Treatment. The following simple measures are advocated as soon as the patient is admitted to hospital. These aim at combating collapse, pain, dehydration, etc., and rendering the patient as fit as possible to withstand operation without unnecessary delay. It should never be so short as to be hurried or so long as to jeopardise the patient's chances of recovery. In the average case about one to two hours are spent on the pre-operative treatment, which may be epitomised as follows:

1. The patient is placed in bed in the half-sitting position and is kept warm by means of radiant heat, electrically heated blankets, etc.

2. Omnopon (gr. $1/3$) with scopolamine (gr. $1/150$), or morphia (gr. $1/4$), with atropin (gr. $1/100$), or any reliable pre-anæsthetic agent is injected to relieve pain and anxiety.

3. No fluids are given by mouth. Normal saline solution with 5 per cent glucose is injected intravenously to combat dehydration and alkalosis and to make good the loss of blood chlorides. Occasionally blood transfusion may be helpful.

4. A soft rubber catheter is passed to ensure that the bladder is empty.

5. The abdomen is prepared. This may be started shortly after the injection of the pre-anæsthetic and when it is evident that some relief has been afforded; but it is better to defer the preparation of the abdomen until the patient is under the anæsthetic in the operating room.

6. The blood pressure, both systolic and diastolic, should be charted on the patient's admission and again shortly before he is removed to the operating theatre. If the systolic blood pressure is low, the contents of two ampoules of sympatol should be injected subcutaneously. The blood pressure findings should be shown to the anæsthetist, since if the blood pressure is unduly low it may influence the choice of anæsthetic.

7. The mouth should be thoroughly washed out with some anti-septic solution before the anæsthetic is administered.

Operative Treatment. The following operations are performed for acute perforated gastric and duodenal ulcer:

1. Simple suture.
2. Closure of the perforation followed by gastro-jejunostomy.
3. Temporary gastrostomy or duodenostomy.
4. Excision of the ulcer and suture—pyloroplasty.
5. Partial gastro-duodenal resection.

Certain points in the technique of these operations, the immediate results, the late results, and the relative merits of each operation will now be discussed.

Simple Suture. Zachary Cope (*Proc. Roy. Soc. Med.*, 31:465, 1938) states that the first successful case of simple suture of a perforated peptic ulcer was carried out by von Heusner in 1892, and that in the following year Hastings Gifford and Morse had successful cases in England. Until about forty-seven years ago the perforation of a peptic ulcer was usually a fatal event. The first operations and those of the next fifteen to twenty years consisted of simple suture of the rupture with two rows of Lembert sutures, washing out the peritoneal cavity thoroughly and methodically with warm water or mild antiseptic solution, and inserting rubber or glass drainage tubes down to the site of the ulcer, to the pelvis, and sometimes to the loins. We now realise that drainage down to the ulcer is unnecessary and even harmful, that irrigation of the general peritoneal cavity is injurious and meddlesome, and that pelvic drainage is only called for in cases of frank peritonitis. Bennett (1896) was the first to suggest that in some cases where the perforation was very large and the opening difficult to suture owing to the friability of the parts, success might be achieved by inserting a plug of omentum into the opening and suturing this in position by a few Lembert sutures. This method is still in use today, although it is more satisfactory to introduce three interrupted sutures, one at the top, one in the middle, and one at the bottom of the perforation, and after laying a piece of omentum over these sutures to tie them sufficiently tightly to hold the omentum in position.

The operation of simple suture is straightforward and quick to perform as it seldom takes more than a few minutes after the abdomen has been opened and does not necessitate any special experience or skill in abdominal surgery, nor does it subject the patient to prolonged anaesthesia or any undue shock. The operation aims solely at warding off the immediate danger in a patient who is seriously ill

and whose life is, in fact, threatened, while subjecting him to the minimum amount of operative trauma.

The object of the operation is therefore not to cure the ulcer *per se*—this can be deferred until a later date when the patient is in a better state of health—but to tide him over the emergency. This being the case, the immediate prognosis should be good—the strongest plea for the performance of this operation.

Simple closure, usually without peritoneal drainage is the method of choice in Britain and America. The replies to Guthrie's questionnaire from a large number of American surgeons show that the majority are conservative and favour the operation of simple suture alone. It would be difficult, as Cope has stated, to expect better results from simple suture than the best of those already published. Gilmour and Saint (*Brit. J. Surg.*, 20:78, 1932) recorded a series of 64 cases of which 63 were treated by simple suture and one by suture followed by gastro-jejuno-stomy. The mortality in cases operated upon within twelve hours was 0.5 per cent, and in cases over twelve hours 15 per cent. The total mortality was 4.7 per cent. Southam (*Brit. M. J.*, 1:556, 1922) lost no case out of 34 duodenal perforations which were operated upon within twenty-four hours of rupture. His mortality for both early and late cases was 9 per cent. Sallick reported 74 cases of perforated peptic ulcer all treated by simple suture, in which there were 8 deaths, a mortality of 10.8 per cent. In this series there were 49 cases operated upon within six hours of perforation, with only one death, 2 per cent. Tilton records 52 cases with one death, Black, 50 cases with one death, Graham, 51 cases with one death, while in the Southend General Hospital series there were 33 consecutive cases with two deaths. All these figures are better than the average, and the following are perhaps more representative. Gibson (*J. Am. M. Ass.*, 91:1006, 1928) treated all his 109 cases irrespective of the time factor by simple suture, and his mortality was 17 per cent. Of Shewan's 307 cases thus treated, 25 per cent died, while Zakschwerdt and Eck in a series of 112 cases had a mortality of 17.3 per cent for those cases operated upon within 12 hours, and a mortality of 36.7 per cent for all cases operated upon.

Although it is generally conceded that of all the methods of treating acute perforated peptic ulcer that of simple suture is associated with the lowest immediate mortality, the late results are, as one

would expect, disappointing. In my experience, approximately 30 per cent of such cases are symptomatically cured, 20 per cent will have recurrent symptoms necessitating medical treatment, while 50 per cent will develop complications requiring further operative measures. Williams and Walsh (*Lancet*, 2:9, 1930) reported that of eight patients with gastric ulcer perforations, five had to come to re-operation. Of their duodenal cases 53 out of 94 required further operative interference. Gilmour and Saint found that 61 per cent of their cases had recurrence of ulcer symptoms. In Platou's series of 25 patients treated by simple closure alone, 16 had recurrent ulcers. Bryce (*Brit. M. J.*, 1:774, 1930) reported that only 32 out of his 100 cases were free from gastric symptoms, while Scotson (*Brit. M. J.*, 2:680, 1933) considered that 58 per cent of his 92 cases were in need of institutional treatment. White and Patterson (*Ann. Surg.*, 94:242, 1931) and Collinson (*J. Am. M. Ass.*, 63:1184, 1914), on the other hand, reported 65 per cent of good late results.

The significant fact emerges that in some 30 per cent of cases a permanent cure is effected by the operation of simple closure. Those surgeons, therefore, who advocate partial gastrectomy or gastro-jejunostomy as a routine procedure at the time of the catastrophe are performing a needless operation in approximately one-third of their cases.

TECHNIQUE OF SIMPLE CLOSURE. The choice of anæsthetic is important. I prefer a spinal anæsthetic for those who are in good condition, and a local anæsthetic combined with a splanchnic block for the poor risk cases. I also favour a median incision as it is relatively atraumatic, it gives ample exposure, and it can be readily and securely closed.

On opening the peritoneal cavity there is often an escape of gas, and the wound may be quickly flooded with contaminated peritoneal fluid. The edges of the wound should be well retracted, the right lobe of the liver drawn upward with a Deaver retractor, and an assistant should grasp the body of the stomach with his left hand and draw it well into the wound so as to bring the pylorus and the first part of the duodenum fully into view (fig. 83).

In most cases the perforation is readily seen. It may be circular and punched out, or oval, and it varies considerably in size, although it usually is about $\frac{1}{4}$ inch in diameter. Through this opening the

stomach contents will be seen to pour intermittently or continuously (fig. 83). In duodenal ulcer perforation the escaping fluid is bile-stained and somewhat frothy, the gut near the perforation is injected, and the margins of the ulcer are hard and merge into the surrounding zone of water-logged and stiffened muscle. If the perforation does not come at once into view, a methodical search of the whole stomach and duodenum must be made. The hole in the

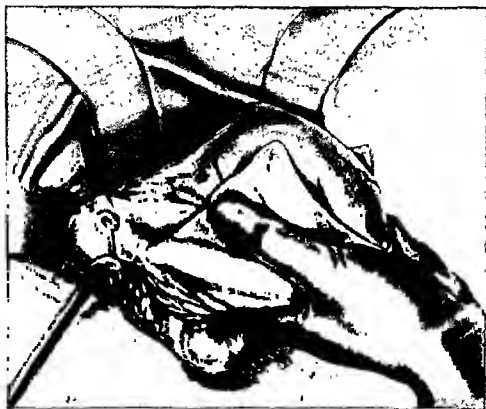


FIG. 83.—PERFORATED DUODENAL ULCER.

stomach or duodenum may be plugged by a portion of omentum, sealed off by flakes of lymph, glued to an adjacent viscus such as the liver, or be situated in a somewhat inaccessible position, e.g., in the cardia. The continuous welling up or gushing forth of fluid from the wound or spot may lead to its detection.

As the ulcer is hard, any localised induration should be carefully examined. The possibility of more than one ulcer or sometimes of

multiple perforations being present should be borne in mind. There may also be a perforation of a posteriorly situated gastric ulcer into the lesser sac. It is possible for an ulcer thus placed to rupture, for the contents of the stomach to distend the lesser sac and for the fluid to pour through the foramen of Winslow and contaminate the general peritoneal cavity. The exact site of perforation is difficult to find in these cases, and even more difficult to close. The fluid in the peritoneal cavity between the ulcer and diaphragm, etc., should be cautiously removed by a suction tube.

There are many ways of closing a perforation. Perhaps the simplest is to introduce three uninterrupted sutures of No. 1 twenty-day chromic catgut or of strong silk, the first above the opening, the second below it, and the third through it. A piece of omentum, either free or attached, is laid over these three sutures, which are then tied gently but with sufficient force to hold the omental pad in situ. The sutures should not be tied too tightly or they will cut out. In the majority of cases this is all that is needed. No attempt is made actually to close the perforation.

A popular alternative method consists of closing the perforation by a series of closely applied Lembert sutures which are introduced in the transverse rather than in the longitudinal axis of the stomach and duodenum in order to prevent any narrowing of the gut (fig. 84). Where it is found easier and more expeditious to pass the sutures in the longitudinal axis, however, there should be no hesitation in adopting this method, even though it may produce a certain degree of stenosis.

In the average case it is possible to close the perforation most efficiently and satisfactorily by the method illustrated in figure 84. Interrupted mattress sutures may be used instead of Lembert sutures. A purse-string suture is not recommended in closing the perforation, except perhaps where the opening is very small and the surrounding induration negligible. It should never be employed for a large perforated callous ulcer, as on attempting invagination the suture will cut out owing to the friability of the tissues. Again, a purse-string suture will often interfere with the blood supply to the edges of the sutured ulcer and thus retard healing.

Irrigation of the peritoneal cavity with warm water, normal saline or mild antiseptic solution has been wisely abandoned as it pro-

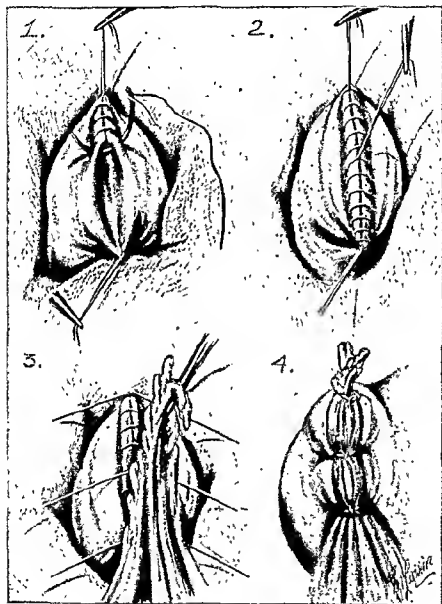


FIG. 84.—PERFORATED DUODENAL ULCER.

The perforation is closed with a series of interrupted sutures, after which the suture line is reinforced with a wisp of omentum.

longs the operation and increases shock. Irrigation, too, might be harmful in disseminating infected fluid and in actually diffusing any localised peritonitis which may be present.

Systematic mopping out of the abdominal cavity is likewise injurious, as is also the too energetic use of a suction tube. When food particles are found in the peritoneal cavity, however, it is essential to proceed methodically with the swabbing.

Supra-pubic drainage is, as already stated, only indicated in cases of generalised peritonitis. It is certainly never required when operation is performed within twelve hours of perforation. The rubber drainage tube should be inserted through a supra-pubic stab wound and never through the lower end of the original epigastric incision, as this predisposes to infection of the wound and to post-operative ventral hernia. Drains are removed at the end of twenty-four to forty-eight hours. The superficial layers of the abdominal incision may be drained with a small piece of corrugated rubber.

The midline incision is closed with four or five tension sutures threaded through fine rubber tubing, the edges of the peritoneum and aponeurosis being united with one continuous suture of No. 1 twenty-day chromic catgut. The skin edges are approximated with fine silkworm gut or deknatel sutures.

When speed in closing the abdominal incision is imperative, when the patient is fat and when the peritonitis is marked, it is safer and in every way more satisfactory to approximate the edges of the wound with through-and-through bronze or silver wire sutures.

Closure of the Perforation followed by Gastro-Jejunostomy
Moynihán (1901) and Patterson (1902) were among the first to recommend the performance of gastro-jejunosomy after closure of duodenal ulcer perforations, especially where the suturing of the opening had produced stenosis or a marked degree of narrowing of the lumen of the duodenum. Deaver (*Ann. Surg.*, 89:529, 1929) has always strongly urged the necessity of the addition of primary gastro-jejunosomy to the closure, and this procedure has been followed by many surgeons including Walton, Pfeiffer, Mills, Alexander and Morrison. The advocates of this method state that the short-circuiting procedure does not increase the mortality in early cases in spite of the operation being prolonged, but may rather reduce it, and that instead of spreading infection it tends to diminish it. Gastro-jeju-

nostomy, in addition to overcoming any immediate apparent obstruction produced by the infolding of the ulcer, relieves the tension on the line of suture and plays an important part in preventing the onset of such complications as recurrence of perforation, scar stenosis and severe hæmorrhage. The short circuiting, by relieving intra-gastric tension and by increasing the alkaline content of the stomach, assists the process of healing of the ulcer and augments the chances



FIG. 85.—BLEEDING CHRONIC DUODENAL ULCER ON THE POSTERIOR WALL.

The anterior wall of the duodenum has been incised and is retracted with Allis forceps. Sutures of strong silk are inserted deeply through the edge and base of the ulcer before they are tied one by one.

of permanent cure. When suture alone is performed, they state, the ulcer will fail to heal in a very high percentage of cases, thus prolonging invalidism, demanding protracted courses of medical treatment and frequently a secondary operation. It is also stated that when suture with primary gastro-jejunostomy is performed, post-operative convalescence is generally uninterrupted, smoother and quicker than when simple suture alone is employed, and that serious post-operative complications are less frequently seen.

foration is small and accessible, when the duodenum can be mobilised easily, when the plastic closure would seem to present no technical difficulty, and when the condition of the patient is generally satisfactory.

Dowden had no deaths in his series. Dunbar reported that the operation in his hands had given most gratifying immediate and late results, while Moynihan (*Practitioner*, 120:137, 1928) recorded 28 cases with only one death—a mortality of 4.5 per cent. Barger, in a series of 78 cases, had a mortality of 11.5 per cent, but lost none of 45 cases in which operation was performed within six hours of the occurrence of the perforation.

This operation has also found favour with Söderland and Hinton. Williams and Walsh (*Lancet*, 2:9, 1930), however, record the very high operative death-rate of 33 per cent.

Partial Gastro-Duodenal Resection. According to Cope, that enterprising surgeon, Keetley, in 1902, had to deal with a large perforated ulcer near the pylorus for which he thought fit to perform a pylorotomy, and although the patient made an excellent recovery and Keetley in consequence warmly advocated this procedure, few surgeons have practised partial gastrectomy for ruptured peptic ulcer until recent years. From 1919 onward Finsterer, von Haberer and other Continental surgeons were urging the adoption of partial gastrectomy for both gastric and duodenal ulcers, and this operation has slowly found favour with British and American surgeons.

It was not surprising that partial gastrectomy should be tried in certain cases of perforated ulcer. While at first it was tried only in cases which came to operation soon after perforation, it was gradually discovered that successful results might be obtained even when the peritoneum was seriously infected. At the present time in some clinics two-thirds or three-quarters of the cases of perforated ulcer are treated by partial gastrectomy (Cope).

The plea made by these Continental resectionists for this method is that multiple peptic ulceration is a much commoner disease in their countries than it is in England or America and that perforated duodenal ulcer is very often associated with chronic gastric ulcer, with multiple erosions of the pyloric segment of the stomach or with acute ulcerative gastritis or duodenitis. Also that recurrent perforation is frequent after simple closure and a large majority of cases so treated

require subsequent gastrectomy. Again, in many cases marginal ulceration develops after short-circuiting operations, often necessitating a secondary gastric resection which is exceedingly difficult to perform and which is followed by a high death-rate.

Graves (*Ann. Surg.*, 98:197, 1933) reviewed 4,402 perforated peptic ulcers in German clinics from 1897 to 1931. Simple closure was reserved for the poorest risks and yielded a mortality of 50 per cent, while gastro-jejunostomy, which was reserved for the better risks, gave a 13.8 per cent mortality. Gastric resection reserved for the best risks gave only 5 per cent mortality. Their total mortality was 23 per cent.

Kuntz (*Arch. f. klin. Chir.*, 160:390, 1930) collected 528 cases of resection for perforated ulcer and found the mortality to be 16.5 per cent. For cases operated upon within twelve hours, the mortality was only 9.1 per cent. Judin, a most accomplished surgeon who is in charge of the Central Emergency Hospital in Moscow, where he works under ideal conditions, is the most outstanding exponent of this method of treatment. The transport facilities at his disposal are excellent, he has a team of well-trained assistants, all versed in emergency methods and themselves expert in gastric surgery, the operating suites are considered to be the best in Europe, and the pre- and post-operative methods of treatments have been systematised and are carefully supervised. Judin points out that before carrying out partial gastrectomy for perforated ulcer the surgeon must carefully consider the number of hours which have elapsed since perforation, the age and general condition of the patient, and the amount of peritoneal infection, and take into account the experience and facilities of the surgeon. He would not advise partial gastrectomy in old patients, in cases of general peritonitis, when intoxication is advanced, when perforation has been present for more than twelve hours, or when the surgeon is not skilled in abdominal surgery. He has found it possible to perform partial gastrectomy (and the method he favours is the Billroth I type of repair) in approximately 80 per cent of the cases admitted to his hospital. His results have been excellent. He records his experiences in these words:

One might expect that such radical procedures—primary resection performed in over 80% of perforated ulcers—would be followed by serious after-effects. Not only was this not true, but the mortality noted in earlier years

when only conservative operations were performed for perforated ulcer were considerably reduced. Thus, for instance, in 1922-1921 our Institute had a mortality of 50% for perforated ulcer. From 1928 on I have systematically done resections for all the earlier cases of perforation in young patients. A comparative analysis based on 207 cases in our Institute shows a death-rate of 11.9% for resection—a reduction of total mortality of 22.3%. A year later I published a study of 116 new cases. The death rate in 98 cases of resection was nearly the same—11.2%.... In 1931, of 152 patients operated upon for perforated ulcers there were 13 fatalities, making a death-rate of 8.5%. This is the lowest mortality we have been able to obtain. Summing up, the general death rate for all operations for perforated ulcer in the last two years, we find 418 operations (266 plus 152); 54 deaths (41 plus 13), that is, 12.8%.⁶

Hoche and Marangos (*Arch. f. klin. Chir.*, 1932) described 18 cases treated by partial gastrectomy with a mortality of 22.4 per cent. They collected from published records 405 cases subjected to resection within twelve hours of perforation and found that only 9 per cent of these patients died. Many other reports of primary resections for perforated peptic ulcer are to be found from foreign sources, some of the more authoritative being by Schwarz (*Deutsche Ztschr. f. Chir.*, 197:56, 1926), Kreuter (*Zentralbl. f. Chir.*, 59:2017, 1932), Hormada and Newman (*Surg., Gynec. & Obst.*, 35:11, 1922), Ciancarelli (*Arch. ital. di chir.*, 39:677, 1935), Kuhlman (*Strasbourg med.*, 93:136, 1933) and Peters (*Chirurg.*, 7:78, 1935).

Convincing as these figures of Judin's, Kuntz's and Hoche and Marangos's and of other resectionists' are, I feel that most British surgeons are in complete agreement with Gilmour and Saint who write on this subject as follows:

Every surgeon must be impressed by the figures quoted above, since in some series the mortality is less than that resulting from the treatment of the perforated ulcer by the simplest possible method—namely, laparotomy and suture. It is obvious, however, that such results can only be obtained where the operator has more than average ability and experience in gastric surgery, quite apart from the fact that the patient's general condition must be good.

The sphere of partial gastrectomy as the treatment for perforated ulcer must necessarily be always restricted to clinics specializing in gastric surgery. We are quite sure that it would be unwise for the average general surgeon to attempt to establish this large resection operation as his routine treatment for perforated ulcer, and think he would be well advised to content himself with some less formidable procedure. We think our experience of a 0.5% mortality in cases

⁶ Judin, *Surg., Gynec. & Obst.*, 61:63, 1937.

operated upon under twelve hours, with a total mortality of 4.7%, fully justifies the simplest operative measures—that is, suture alone.¹

In summing up these considerations I feel that most surgeons would agree with me when I say that in acute perforated peptic ulcer operation is a life-saving measure in that nothing beyond suture of the perforation should be carried out in the way of treating the ulcer. This should be done if necessary at a secondary operation. Nevertheless, in exceptional circumstances, such as perforated duodenal ulcer associated with severe bleeding, gastrectomy may be advised.

POST-OPERATIVE COMPLICATIONS

Pneumonia and peritonitis account for over 95 per cent of the deaths. In Grey Turner's series (*Lancet*, 1:183, 1925) of 147 cases, 23 patients developed some serious complication and this bears out the general statement that following such operations there will be complications in on an average of one case in every six.

Sub-phrenic abscess, pelvic abscess or empyema may develop in the later stages of recovery. Gastric and duodenal fistulæ parotitis, disruption of the abdominal wound and phlebitis are comparatively rare complications.

Sub-Acute Perforated Peptic Ulcer. Sub-acute perforation occurs only in connection with chronic peptic ulcer. In such cases a history of chronic indigestion is always obtained, and shortly before perforation takes place there is an acute exacerbation of the symptoms. The onset of perforation itself is sudden, but the peritonitis which results is strictly localised owing to the small quantity of fluid which escapes from the rent in the stomach or duodenum and to the fact that it is rapidly walled in.

The initial symptoms and signs of a sub-acute perforation are similar to those of acute perforation, *i.e.*, sudden epigastric pain, abdominal rigidity and tenderness, and a certain degree of prostration, but they are always less intense in nature. The abdominal rigidity is more marked over the region of the extravasation; elsewhere guarding may be absent or, if present, it yields on pressure and there is no tenderness of the pelvic peritoneum on digital rectal examination.

¹ Gilmour and Saint, *Brit. J. Surg.*, 22:78, 1932.

On examination it may be impossible to make a differential diagnosis between sub-acute perforation (leaking peptic ulcer) and acute perforation, nor is this distinction often a matter of great import as operation must be performed in such cases whenever the diagnosis is in doubt. In certain cases, however, on the strength of the history, the sequence of the symptoms and the localisation of the signs, such a differentiation may be readily made.

If operative interference is withheld and medical treatment is undertaken, one of two results may be expected:

1. The abdominal tenderness and rigidity may gradually disappear and the ulcer heal; or
2. A localised abscess—peri-gastric or sub-phrenic—may form, which may rupture and infect the general peritoneal cavity, producing a septic peritonitis.

Studied conservatism may be justifiable in certain circumstances. For instance, in the early acute case where the diagnosis is in any doubt and where the patient is a poor operative risk, it is wiser to adopt conservative methods of treatment provided that all facilities are at hand for immediate operation should this prove to be necessary.

Again, if the patient is seen for the first time many days after perforation has occurred and there is sufficient evidence that the infective process is definitely limited and that a localised abscess has formed, more is to be gained by waiting than by performing an injudicious exploration for a condition which is likely to resolve. When operation is undertaken at a later date in such cases, owing to the reduction in the size of the ulcer, operative measures for the cure of the condition are rendered easier and more satisfactory. On the other hand, if the peri-gastric abscess does not resolve, expectant treatment will ensure its being securely shut off when drainage, which is often of a temporary nature, is undertaken.

I must emphasise that if the diagnosis is uncertain or if the patient shows no improvement after a trial of expectant treatment, operation should be carried out without further delay.

CHAPTER 14

THE MANAGEMENT OF BLEEDING PEPTIC ULCER

During recent years few subjects have aroused more controversy than the treatment of severe bleeding from intrinsic gastric and duodenal lesions, and particularly when the hæmorrhage is associated with chronic peptic ulceration. The student will derive no guidance from a perusal of statistics but will rather be bewildered by the discrepancies between the figures quoted by the various authors working not only in different centres but in one town and actually in the same hospital. He will be surprised to find that the mortality of hæmorrhage from gastric and duodenal ulcers under medical treatment, even when carried out in precisely the same manner and by the most competent workers, varies from 1 to 25 per cent and that the death-rate from operative interference may be as low as 5 per cent or as high as 75 per cent. He will notice that there is still a lack of co-operation between physician and surgeon in the management of these cases; that physicians are not agreed among themselves as to the ideal methods of medical treatment—should these patients be starved or should they be fed at once on the generous and liberal fare advocated by Meulengracht?—that the indications for surgical intervention are difficult to define, as each case has to be judged largely on its own merits; that the judgment of the surgeon is of greater importance than his technical skill; that there is no one standard operation for the bleeding ulcer, but rather that many are practised; and that there is a large body of medical men who believe that the mortality from bleeding ulcer cases is so low as to be almost negligible, and that the treatment should invariably be conducted on conservative lines.

The truth of the matter is surely this; that all cases of severe hæmatemesis or melæna are best treated in hospital; that blood transfusion by the continuous drip method is a life-saving measure; that there should be a closer co-operation between physician and surgeon in the management of these difficult and anxious cases; that Meulen-

gracht's method of treatment with food is rational and sound; that some cases can only be rescued by timely surgical intervention; and that surgery if it be required during active ulcer-hæmorrhage is best undertaken within forty-eight hours of the bleeding, since postponement beyond this time often renders operation an almost forlorn hope.

CAUSES OF GASTRIC AND DUODENAL HÆMORRHAGE

There are many conditions which cause bleeding from the upper gastro-intestinal tract, but in approximately 90 per cent of cases the culpable lesion is peptic ulcer. This statement is supported by the figures of Pauchet, Finsterer, Rivers and Bulmer. Thus Pauchet (*Clinique*, 22:363, 1927) considered that 90 per cent of cases of profuse hæmatemesis concerned gastric and duodenal ulceration and that only 10 per cent were due to diseases of the liver, spleen or appendix; Finsterer (*Jour. de chir.*, 42:673, 1933) affirmed that in 98 per cent the bleeding originated from an artery in the base of a gastric or duodenal ulcer. Rivers and Wilbur (*J. Am. M. Ass.*, 98:1629, 1932) who studied 668 consecutive cases of hæmatemesis at the Mayo Clinic places the relative frequency as follows: (1) Intrinsic gastro-duodenal lesions—90.5 per cent; (2) cirrhosis of the liver and splenic anæmia—5.1 per cent; (3) all other causes—4.4 per cent. In Bulmer's series (*Lancet*, 2:720, 1932) of 649 cases only 71 were due to causes other than gastric and duodenal ulcers. Of Bulmer's 578 peptic ulcer cases 321 were chronic ulcers and 257 acute; in other words, in nearly half the cases (321 out of 649) of severe bleeding from the upper gastro-intestinal tract investigated by him the lesion causing the bleeding proved to be a chronic gastric or a chronic duodenal ulcer.

Acute peptic ulcer is a common cause of hæmatemesis and melæna and it accounted for 257 out of 649 cases in Bulmer's series.

There are a number of patients who bleed profusely and without any warning and who also have recurrent hæmorrhages without any antecedent history of indigestion and even without any demonstrable evidence of ulceration in the upper gastro-intestinal tract. These are often grouped as cases of gastrostaxis or multiple acute mucosal erosions.

Surgery should not be invoked as a means of arresting hæmor-

rhage for cases of acute peptic ulcer, for acute ulcerative gastritis and duodenitis which are uncomplicated by chronic peptic ulcer, or for gastrostaxis. These conditions are best treated by medical measures and by the transfusion of blood.

Gastric cancer and innocent new growths of the stomach are rare causes of profuse hæmatemesis and are readily diagnosed on radiological investigation. Vomiting of blood may nevertheless be the first symptom to herald the presence of a neoplasm in the stomach. Although patients with malignant or benign tumours of the stomach may be profoundly anæmic from continuous loss of blood, urgent exploration is never needed in their cases.

Diseases resulting in the formation of gastric and oesophageal varices are relatively important in the causation of gastric bleeding. Hepatic cirrhosis and splenic anæmia are the most important of these diseases, but neither necessitates immediate operation. The late results of splenectomy for splenic anæmia are disappointing as half of the patients who survive operation die from gastro-intestinal hæmorrhage within five years. Repeated hæmorrhages, often profuse in nature, following operative measures for hepatic cirrhosis or splenic anæmia, are often terminal events and frequently prove unresponsive to any forms of treatment. In essential thrombocytopenic purpura hæmorrhagica associated with bleeding from the stomach, the diagnosis is based mainly upon the very low platelet count, the prolonged bleeding time, the positive tourniquet test (page 564), and secondary anæmia without any constant changes in the erythrocytes. Splenectomy performed at the time of election is curative. Hæmatemesis may also be associated with acute obstructive cholecystitis or with acute appendicitis, but in these cases the sequence of the symptoms and the physical findings will direct the line of operative attack.

The vomiting of blood is not infrequently seen as a complication in cases of septicæmia, in septic peritonitis, in pernicious anæmia, in uræmia, etc.; but these conditions are, as a rule, not difficult to diagnose.

Gordon-Taylor, whose valuable articles and lectures have done so much to reawaken surgical interest in ulcer-hæmorrhage, writes:

Before any decision is taken in the matter of operating for, and in the presence of, severe hæmatemesis, the greatest caution must be exercised to

ensure absolute accuracy in the diagnosis and causation of the hæmorrhage, for almost the only pathological state which justifies urgent surgery is that of *bleeding from a chronic ulcer*. There should preferably be clinical, radiological, even biochemical evidence of the existence of a chronic ulcer, or if the details of the patient's previous history are not available, the anamnesis should leave in the observer's mind no doubt as to the existence of a chronic ulcer of stomach or duodenum and no uncertainty as to this being the source of the cataclysmic menace to the patient's safety.¹

THE INCIUENCE OF HÆMORRHAGE

The statistics of Moynihan, Balfour and Hurst are similar; bleeding occurred in 20 per cent of gastric ulcers and in 25 per cent of duodenal ulcers. Allen and Benedict (*Ann. Surg.*, 98:736, 1933) investigated 1804 cases of duodenal ulcer and found that 628 (or 30 per cent) of the patients bled.

THE MORTALITY OF ULCER-HÆMORRHAGE

Meulengracht (*München. med. Wchnschr.*, 40:1565, 1937) reports a mortality of 1.3 per cent in a group of 368 consecutive cases. The following low death-rates are recorded: Conybeare 2.5 per cent; Emery and Monroe 4.1 per cent; Kruse 5 per cent; and Lahey 5 per cent. Aitken (*Lancet*, 1:839, 1934), who studied the London Hospital figures for 1929-1934, found a mortality of 11 per cent; but in the cases classified as *severe* the mortality was 42.8 per cent. Bulmer (*Brit. M. J.*, 1:848, 1933) found that in cases of hæmatemesis due to chronic peptic ulcer treated by medical measures there was a mortality of 11.6 per cent. The figures given by Hinton and by Goldman are almost identical—11 per cent. Hellier, dealing with the Leeds cases, records a 14.8 per cent fatality. Cullinan and Price (*St. Barth. Hosp. Rep.*, 65:185, 1932), in a most useful paper, reported a mortality of 18.1 per cent. Gordon-Taylor (*Proc. Roy. Soc. Med.*, 27:1524, 1934) states that the mortality of the Middlesex Hospital cases of hæmorrhage from chronic peptic ulcer treated medically amounted to 21 per cent, and that Cook found the death-rate to be 24.1 per cent in 191 cases treated at St. Thomas's Hospital. Pfeiffer and Martin (*Am. J. Surg.*, 40:55, 1938) consider that in America the

¹ Gordon-Taylor, *Lancet*, 2 811, 1935.

mortality from massive hæmorrhage complicating peptic ulcer is 5 per cent or more on medical treatment.

The most dependable prophylactic measure against ulcer-hæmorrhage is efficient medical treatment.

FACTORS AFFECTING PROGNOSIS

1. **Age.** It is generally agreed that the incidence and the mortality of ulcer-hæmorrhage increase with age. Ulcer-hæmorrhage is most common between the ages of 40 and 60. Few patients die of the complication under the age of 40. Thus in Cullinan's and Price's series of 105 cases there were no deaths under the age of 30, and only 3 deaths under the age of 40. Operation should not be advised in patients under 40 years of age unless there is concomitant acute perforation.

2. **Sex.** The incidence and the mortality are lower in women than in men. Cullinan and Price noted that there were twice as many male as female cases, and even allowing for this the male mortality was much higher. Thus of the admissions there were 72 males with 16 deaths, and 32 females with 3 deaths.

3. **Acute and Chronic Ulceration.** It is agreed that the prognosis is better in acute than in chronic ulcer, although all observers are agreed that during the active phase of ulcer bleeding it is difficult to distinguish the two conditions by ordinary clinical methods.

4. **Recurrence.** Recurrence of hæmorrhage is the most dangerous prognostic sign. The mortality rapidly mounts when the second or third hæmorrhage closely follows the initial bleeding. Furthermore, the larger the number of recurrences, the greater the mortality. In 40 per cent of the fatal cases death occurred within 3 days, and in 25 per cent death took place actually on the third day. Gordon-Taylor writes most convincingly on this point. He says:

The mortality of cases of hæmatemesis from chronic ulcer of the stomach and duodenum treated medically at the Middlesex Hospital from 1925-1935 inclusive, in which a second large hæmorrhage took place, was no less than 78%, and with each successive bleeding the death-rate became higher. Confirmation of the dangers of recurrent ulcer-hæmorrhage are to be found in Chiesman's paper based on the St. Thomas's Hospital figures from 1925-1931; in these patients in whom the hæmorrhage continued or recurred within 24

hours of the commencement of treatment, there was a mortality of 74%. It is well known that the hæmorrhage-period in cases of bleeding chronic peptic ulcer usually lasts for several days, and that it is the rapid recurrence of bleeding which occasions anxiety and which may prove fatal.²

Cullinan and Price likewise showed that the mortality rose sharply to 40 per cent with recurrence and even reached 60 per cent in patients with more than one recurrence.

If no further bleeding manifests itself during the first five days after the "original attack," the prognosis is tolerably good. Death may, nevertheless, occur some time after bleeding has apparently ceased, and for this reason the condition of the patient continues serious as regards life for one month after a severe hæmorrhage has taken place.

Lahey (*Penn. M. J.*, 41:79, 1937) states that 40 per cent of patients who have bled once will not be controlled by medical measures, and that 80 per cent of patients who have bled on two or more occasions will not be controlled by medical measures.

SCHEME OF MANAGEMENT

1. Every case of severe hæmatemesis or melæna, whatever the cause, should be transferred to hospital without delay.

2. On admission to hospital the patient should be examined forthwith by the physician in charge, who will also arrange for the following investigations to be carried out:

- (a) Complete blood examination. This includes red cell count, hæmoglobin estimation, blood group, estimation of blood volume and plasma volume (Rowntree and Brown: *Collect. Papers Mayo Clinic*, 20:639, 1938), blood urea estimation, etc.

- (b) Examination of the voided material.

- (c) The pulse-rate should be recorded every 15 minutes, and the systolic and diastolic blood pressure every hour.

3. As soon as the physician is in possession of all the relevant facts of the case he should seek the co-operation of a surgical colleague for the purpose of consultation.

4. Donors of a similar blood group to that of the patient should be available, and immediate arrangements should be made to transfuse

² Gordon-Taylor, *Brit. J. Surg.*, 25:98, 1937.

the patient. Gordon-Taylor advises that in every patient in whom bleeding is more than slight, *i.e.*, a pulse-rate of 100 or more and a hæmoglobin estimation of say 60 per cent, a drip blood transfusion should be commenced at once. He also considers that a pulse-rate which remains over 100 indicates a great loss of blood and a risk in any prospective surgery: a patient with a hæmoglobin estimation of only 50 per cent is in a relatively poor state to stand a resection should such be deemed necessary at the time of operation. The estimation of blood volume will also supply a valuable clue as to the amount of blood the patient has lost. The continuous drip blood transfusion method as perfected by Marriott and Kekwick (*Lancet*, 1:977, 1935) is so universally recognised as being indispensable in cases of hæmorrhage that it is unnecessary here to stress its many virtues. It has rendered many seemingly hopeless cases fit for surgery and for medical treatment.

5. Meulengracht's regime is prescribed:

The reasons which induced me to change the treatment hitherto given—namely, fasting followed by very cautious feeding—were:

(a) that exhausted patients often died after hæmorrhage, in spite of scrupulous dieting; (b) that sometimes patients with protracted hæmorrhage stopped bleeding when they were given food; and (c) that very often ambulant patients recovered from severe mæna without making any particular change in their ordinary diet. Furthermore, it seemed to me of questionable advantage to starve a patient at a time when he is presumably in special need of support. I had my doubts whether it was really desirable that the stomach should be empty of food and contain free acid gastric juice, and I thought it improbable that a diet insufficient in calories and vitamins was ideal as a means of promoting healing of ulcers. . . .

From the day after their admission to the hospital all the patients are given a full puree diet, together with a mixture consisting of sod. bicarb. and mag. subcarb. (āā 15.0 grammes), and extract hyocyan 2.0 g.; one teaspoonful three times daily; also 0.5 g. ferri lactas t.i.d.s. The puree diet includes the following meals:

6 A.M.: Tea, white bread and butter.

9 A.M.: Oatmeal with milk, white bread and butter.

1 P.M.: Dinner.

3 P.M.: Cocoa.

6 P.M.: White bread and butter, sliced meats, cheese and tea.

The dinner includes a variety of dishes—*e.g.*, meat balls, timbale, broiled chops, omelette, fish balls, vegetable gratin, meat gratin, fish gratin, mashed potatoes, vegetable purees, vegetable soups, cream of vegetables, stewed apricots, apple

sauce, gruel, and rice and tapioca pudding. The patients are allowed to have as much as they want.³

Vitamin C is supplied in orange, lemon and tomato juice. Marmite is given once a day for the vitamin B complex, and cod-liver oil and malt or one of the concentrates of vitamins A and D is added to some of the daily meals. In order to avoid disturbing the patient or provoking fresh bleeding, no aperients are given, and enemata are postponed until about the sixth day. The patient is best nursed in the semi-sitting position.

6. Indications for surgery are as follows:

(a) Immediate operation is indicated and may on occasion be feasible in cases of torrential bleeding, where it is obvious that some large artery, *e.g.*, the splenic, left gastric, hepatic, etc., in the base of a chronic ulcer has been eroded.

(b) Immediate operation is indicated in rare cases of concomitant ulcer-hæmorrhage and perforation.

(c) Early operation (within forty-eight hours of the first bleeding) is indicated in those ulcer-hæmorrhages in which drip blood transfusion is failing to control the blood volume and hæmoglobin reading—the bleeding is continuous.

(d) Early operation is indicated as soon as the hæmoglobin has reached 60 per cent with the drip still running in: (i) patients in whom a recent X-ray examination has revealed a large penetrating ulcer; (ii) patients giving a long and unequivocal history of peptic ulcer denoting that the ulcer is callous; (iii) patients over the age of 50 who, although they have been under medical supervision, have had one or more previous ulcer-hæmorrhages. If in addition the patient has pyloric stenosis or mid-gastric narrowing, the indications for surgery are more cogent. The treatment of hæmorrhage in connection with marginal ulceration is discussed on page 398.

Operation should be undertaken only in definite cases of ulcer. Perhaps the most obvious indication for early operation is massive hæmorrhage in a patient over the age of 50 who is known to be suffering from a chronic peptic ulcer, who is not responding satisfactorily or promptly to drip blood transfusion, and in whom bleeding recommences within twenty-four to forty-eight hours of the initial hæmor-

³ Neulengracht, *Lancet*, 2 1220, 1935.

rhage. Late operation, *i.e.*, operation performed after the first forty-eight hours, in an exsanguinated patient, is a desperate undertaking. Arresting the hæmorrhage at this late stage cannot repair the damage to the parenchymatous organs, especially the kidneys and liver, occasioned by prolonged anemia.

It must be emphasised that if operation is to be performed it should be carried out within the first twenty-four to forty-eight hours after the initial bleeding. The surgeon's main object in operating is to arrest hæmorrhage by direct attack upon the bleeding point, but it is not always feasible to perform resection.

No pre-anæsthetic is required, and the operation should be performed under local anæsthesia supplemented by a splanchnic block. The abdomen is explored through a mid-epigastric incision and the causative lesion revealed.

If the patient has a *chronic gastric ulcer*, if he is in relatively good condition, and if the parts lend themselves readily to resection, partial gastrectomy should be carried out, as this is the best procedure. If, on the other hand, the ulcer is somewhat inaccessible or is deeply pitting the pancreas, and resection appears too complicated and prolonged an undertaking for the strength of the patient, the ulcer should be exposed through an incision in the anterior wall of the stomach. Four crossed mattress sutures of strong silk are then passed through the periphery of the ulcer and tied firmly, thus effectively controlling all bleeding. The operation is completed by closing the incision in the anterior wall of the stomach at right angles to the curvatures.

The operative treatment of the *bleeding duodenal ulcer* presents many problems. The question of whether to perform a partial gastro-duodenal resection, thereby removing the cause of the hæmorrhage and at the same time curing the patient of his disease, or to ligate the bleeding artery by a series of transfixion sutures, must be settled by the surgeon on the basis of the patient's age and condition, his own experience in gastric surgery, the site and condition of the ulcer, and the facilities which are at his disposal. There is no operation which will afford the patient greater protection against recurrence of hæmorrhage than resection. When therefore the patient is operated upon within the first forty-eight hours, when he appears to be in a satisfactory condition, when the duodenum can be freely

mobilised and the ulcer is not too extensive in size or too firmly welded to the underlying indurated pancreatic head, partial gastroduodenal resection should be carried out while the blood drip is regulated at a slow but even pace. This operation is feasible in 25 per cent of the cases.

When resection is considered too hazardous, the ulcer should be exposed by an ample incision through the anterior duodenal wall and pyloric sphincter. The edges of the wound in the gut are then held widely apart with Allis forceps to allow of a good view of the deep, chronically calloused ulcer bed in which lies the perforated artery—this may be the gastro-duodenal or the pancreaticoduodenal—which may be actively bleeding or shrouded in a mass of black altered blood. Four crossed mattress sutures of strong silk are now inserted deeply through the edge and base of the ulcer and tied tightly (fig. 85). This controls the bleeding and obliterates the ulcer, and, to my mind, is the most efficient emergency method of dealing with the bleeding artery. The long wound in the anterior wall of the duodenum and pylorus is next closed transversely, as in Judd's pyloroplasty, or the incision in the duodenum and pylorus may be extended in both directions and the operation completed by the method introduced by Finney.

In my opinion it is not safe to cauterise or to coagulate the base of these ulcers, although I see that such measures have been sanctioned by many surgeons. There are certain cases in which partial gastrectomy is unwarranted and in which also the exposure of the ulcer by incising the duodenum is impracticable owing to the deep fixation of the duodenum to the right of the spine. In such instances it is common to find that scarring and inflammatory œdema are widespread, the duodenum, in fact, appears to be encased in a sodden, leathery envelope which widely involves the adjacent omenta. When such conditions are encountered it is a simple matter to occlude the pylorus and to perform a posterior gastro-jejunostomy.

I fully realise that an indirect operation can have little effect in arresting hæmorrhage, that gastro-jejunostomy affords but little protection against recurrence of bleeding, and that this operation as a means of treatment in cases of ulcer-hæmorrhage has been widely condemned; nevertheless, I maintain that when local conditions are such as to preclude any radical resection or any form of direct attack

upon the bleeding artery, gastro-jejunostomy may at times effect a surprising cure.

The immediate and late results in four patients upon whom I was constrained to perform this operation were in every respect most encouraging. Two of the patients who were operated upon over five years ago were very fat and had small, high-lying stomachs—an unsatisfactory type for any short-circuiting operation; yet, desperately ill as they were from the loss of blood at the time of operation, they made uneventful recoveries and remain in good health today.

THE RESULTS OF SURGICAL TREATMENT

Gordon-Taylor (*Univ. Toronto M. Bull.*, Ap. 1938) records his operative results in cases of ulcer-hæmorrhage as follows:

	Operations	Recovery	Deaths	Mortality per cent
1919-1921	22	20	2	9.0
1921-1926	10	6	4	40.0
1926-1933	10	8	2	20.0
1933-1938	21	19	5*	23.8

* Two of the 5 fatalities were hopeless cases.

The time factor is of greater importance than surgical technique and perhaps almost as valuable as good surgical judgment. Early operation is as important for success here as it is in acute perforation. The blood drip may possibly have extended the period of time during which surgical incursion may give promise of success, but if surgery is required Finsterer's "first forty-eight hours" is still the time limit within which to operate.

Finsterer (*Lancet*, 2:303, 1936) has shown by his own statistical figures that the time factor is all-important. In his series of 59 cases which were operated upon within the first 48 hours there were only 3 deaths—a mortality of 5 per cent. In a series of 42 cases in which late resections were carried out for massive hæmorrhage, there were 13 deaths—a mortality of 31 per cent.

CHAPTER 15

CHRONIC DUODENAL ILEUS

In chronic duodenal ileus there is a constant or recurrent delay in the passage of duodenal contents, with or without dilatation of the duodenum and with or without demonstrable mechanical obstruction. The condition has been described under the following titles: chronic duodenal stasis; chronic duodenal obstruction; chronic duodenal dilatation; chronic duodenal retention; and chronic obstruction and dilatation of the duodenum.

Cases of chronic duodenal dilatation associated with stasis but occurring without any evidence of mechanical obstruction are very difficult to explain and also to treat on rational lines. There are two types: the congenital and the acquired.

In the *congenital type*—megaduodenum congenitum—the condition is neurogenic in origin and in all probability is due to some nervous imbalance, related to achalasia of the cardia (cardiospasm), to the megacolon (Hirschsprung's disease) or to other similar causes.

In some cases there is a history of indigestion and vomiting dating back to childhood. The condition may be present with or without any evidence of interference with function. Dubose (*Surg., Gynec. & Obst.*, 29:278, 1919) recorded a case in an infant, Downes (*Ann. Surg.*, 66:436, 1917) described the condition in a child of 4½ years of age, and Balfour and Gray (*Surg. Clin. N. Am.*, 12:862, 1932) reported the case of a patient aged 41 in whom the presence of megaduodenum congenitum was confirmed by exploratory operation. Kraas (*Beitr. z. klin. Chir.*, 157:489, 1933) gave a detailed account of six cases in adults in which the diagnosis was confirmed by X-ray examination and by operation. In none of these reported cases was there any demonstrable mechanical obstruction.

There are two varieties of the *acquired type*: In the former—the functional variety—the duodenum is temporarily dilated due to associated disorders. McGehee (*Am. J. Surg.*, 40:140, 1938) who has made a special study of this subject considers that signs of dysfunc-

tion may or may not be present, and that size and function are restored to normal on recovery from the causative disorders. The second variety may be associated with peptic ulcer or with gastric syphilis, or may follow abdominal operations. Unless the dilatation is of an extreme character, cases of this type are relatively asymptomatic.

The surgeon is more concerned with chronic duodenal stasis, which is due to *definite mechanical obstruction*. The obstructing agent may be a result of:

1. **Intrinsic Lesions:** (a) Innocent or malignant growths, e.g., cancer of the papilla of Vater; (b) peptic ulcer; (c) foreign bodies, such as gall-stones, hair-balls, *Tania saginata*, etc.; (d) congenital defects (Ladd, *J. Am. M. Ass.*, 101:1453, 1933).

2. **Extrinsic Lesions:** (a) Pressure of the superior mesenteric artery, of the ileo-colic artery, or of the right colic artery (this is by far the commonest cause); (b) congenital or acquired bands or adhesions causing angulation of the duodenum, the duodeno-jejunal flexure or the first loop of the jejunum; (c) congenital anomaly of curvature or rotation (Kellogg, *The Duodenum*, 300, 1933); (d) cancer of the tail or of the body of the pancreas, cancer of the stomach; malignant glands in the root of the mesentery, tuberculous or lymphadenomatous glands lying along the superior mesenteric blood vessels as they cross the duodenum, etc.; (e) cicatrization following stomach ulceration after gastro-jejunostomy.

Chronic duodenal ileus was first described by Petit (Paris Thesis, 67, 1900), but we are indebted chiefly to the following surgeons for a correct understanding of the causes and of the methods of treatment: Staveland (*Bull. Johns Hopkins Hosp.*, 19:252, 1908); Bloodgood (*J. Am. M. Ass.*, 59:117, 1912); Wilkie (*Brit. J. Surg.*, 9:204, 1921); the Kelloggs (*Ann. Surg.*, 73:578, 1921); Waugh (*Brit. J. Surg.*, 17:343, 1920); and Robertson (*Surg., Gynec. & Obst.*, 40:206, 1925).

In the type due to mechanical obstruction, as a result of the continued intermittent blockage, the duodenal wall becomes thickened and the pylorus stretched. Wilkie regarded chronic duodenal ileus as a predisposing cause of duodenal ulcer and to a less extent of gastric ulcer, and this view is supported by Hurst, Alvarez and many others. Wilkie found evidence of chronic peptic ulceration in 35 out

of 135 cases of chronic duodenal ileus operated upon by him. He also considered regurgitant vomiting following gastro-jejunostomy to be in some cases due to a pre-existing duodenal ileus, although it should be remembered that the ileus may be of a temporary nature and may follow any abdominal operation.

DIAGNOSIS

This is made on the history of the case, the physical examination of the patient, the radiological examination of the stomach and duodenum, and by exploratory operation. Although, as I have shown, there are many causes of chronic duodenal ileus and many clinical pictures may be presented, the following account may be taken to be more or less characteristic of that large group of cases which are sooner or later referred to the surgeon for advice:

The patient is usually a thin woman in whom visceroptosis is present. The symptoms often date back to infancy, and the patient regards herself as having a "weak stomach" which is easily upset by certain articles of diet. The early symptoms include gastric flatulence, nausea, epigastric discomfort and mild attacks of bilious vomiting; but when adult life is reached the symptoms become more severe and persistent and do not respond readily to treatment. Epigastric pain and distension arise during or shortly after the intake of food and are aggravated by standing or by exercise. The patient will often complain that she is unable to finish her meals as there is a sense of insufferable oppression in the abdomen which feels tight to bursting point. On such occasions she will often resort to self-induced vomiting, and large quantities of gas will be belched up together with thin, bitter-tasting, bile-stained fluid. Every few weeks there will be an exacerbation of symptoms—bilious attacks in which the patient will feel ill and prostrated by severe bouts of colicky pain and vomiting. Constipation is a troublesome feature, as is also the loud splashing and gurgling noise which may be heard in the abdomen.

The patient will derive little or no benefit from many and varied courses of medical treatment, from the wearing of special abdominal belts, from massage, or from special diets, but will, however, obtain some relief from postural treatment, *i.e.*, by lying face downward

or by assuming the genupectoral position when the pain is at its height.

Physical examination rarely reveals any positive sign, but epigastric distension may be observed in extreme cases. Radiological examination of the stomach and duodenum following the administration of a barium meal is of all methods of investigation the most valuable and reliable. In a well-established case, dilatation of the duodenum with stasis, often with a "mosaic" pattern of the mucosa, will be observed, and reverse peristalsis may be noted. In addition, the presence of visceroptosis may give an indication of the causal factor.

In the differential diagnosis the following conditions will have to be considered: chronic peptic ulcer, duodenal diverticulum, chronic appendicitis, chronic cholecystitis, tuberculous mesenteric glands, gastropptosis, coloptosis and neurosis.

TREATMENT

Medical treatment should be given a trial and will consist of the following: rest in bed with the foot of the bed elevated, abdominal massage, a non-residue diet, duodenal aspiration followed by lavage, abdominal exercises and special abdominal binders and supports.

Such remedies may yield relief in some of the milder cases, but it is very doubtful whether they will have any effect upon the severe cases associated with obstruction. For the latter the operation of duodeno-jejunostomy, as first suggested by Barker and Bloodgood and as first performed by Staveland in 1908, should be carried out.

This operation is a simple undertaking, and when the indications are indisputable the immediate and late results are good. In certain instances a definite band or adhesion may be the causative factor, and when such is found, simple division of the obstructing agent will, in the majority of cases, suffice to effect a cure. When, however, the obstruction is due, as it often is, to compression of the third or fourth portion of the duodenum by the superior mesenteric blood vessels, duodeno-jejunostomy should be performed. The transverse colon is drawn through the wound and elevated, thus exposing the prominent bulging third part of the duodenum, the peritoneum over it is incised and the gut freely mobilised. The first loop of the

jejunum, some 6 to 8 inches from the duodeno-jejunal flexure, is then brought over to the right and anastomosed to the mobile duodenum as in the performance of a gastro-jejunostomy.

At the completion of the operation the edges of the mesocolon are stitched to the line of anastomosis. The opening should be at least 2 inches wide and the suturing should be done with fine chromic catgut.

Gastro-jejunostomy is not advised because it often fails to afford relief and may even aggravate the condition by producing adhesions or kinking at the actual site of the anastomosis. Where there is a mild degree of mobility of the cæcum or ascending colon, some surgeons recommend that cæcoplexy or coloplexy should be carried out; but I have not found this added procedure advantageous.

The after-treatment is conducted on the same lines as for gastro-jejunostomy. Immediate relief is usually experienced and in clear-cut cases this proves to be of a permanent nature.

Wilkie performed duodeno-jejunostomy upon 127 cases with a mortality of 6.5 per cent. He considered that operative treatment gave on the whole "a gratifying impression."

CHAPTER 16

GASTRIC TUMOURS

These are carcinomata, sarcomata and benign growths.

CARCINOMA

Cancer of the stomach can be cured only by gastrectomy, and by this method alone can the patient's life be saved. All non-surgical methods of therapy, including deep X-rays and radium, although they may afford some temporary alleviation, have a mortality of 100 per cent. Furthermore, cure is not possible except in a certain proportion of cases in which the disease is still intrinsic, i.e., when it is limited to the stomach; but the disease is intrinsic only in its early stages. As fully 50 per cent of patients suffering from gastric cancer are beyond the reach of exploratory laparotomy when examined by the surgeon for the first time, it is obvious that no improvement is possible in the present situation unless these cases are referred to him at a much earlier period in their illness than they have been hitherto. The fight against cancer is a fight for earlier diagnosis and thus for earlier radical treatment.

Ætiological Factors

Incidence. The stomach is the commonest site of malignant disease. Haberman found that of 27,511 cases of fatal carcinoma examined post mortem, 41.5 per cent were situated in the stomach, while D'Espère calculated that 44.3 per cent of all cancers occurred in the stomach. In 1925 cancer of the stomach was responsible for 11 per cent of the general death-rate in the British Isles, whereas in 1935 the figure had increased to 13 per cent. Statistics reveal that of those over the age of 45 now living, one person in every 32 will in all probability die of cancer of the stomach. In Great Britain between twelve and fifteen thousand people die of cancer of the

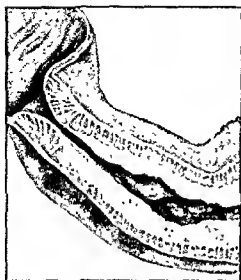
stomach each year. The economic seriousness of the disease in America can best be appreciated by the fact that between thirty and forty thousand of the yearly 120,000 deaths from cancer concern the stomach itself.

Let us examine the figures for the year 1934. In England and Wales there were in that year 55,232 deaths from cancer, and 12,269 of these originated in the stomach. There were approximately 6,600 men and 5,600 women. These figures are probably an underestimate as it is well known that many cases of cancer of the stomach are notified as having died of certain complications such as pneumonia, ascites, intestinal obstruction and so forth, in other words, of the disease which hastened the end. For instance, in the year under review 2,400 deaths were notified as from cancer of the liver. Surely in many of these the large "knobbly" liver dominated the clinical picture and masked the silent primary lesion in the stomach.

A study of the statistics of the United States for the same year reveals that 26,769 persons died of gastric cancer. This is a conservative estimate, as Maes, Horsley, Balfour, Cramer, Minnes and Geschickter have sought to prove in their interesting papers. Balfour places the figure at 38,000. Cramer (*Lancet*, 1, 1934) states that: "Gastric carcinoma dominates the total incidence of cancer, for in most countries it is responsible for more than half of the total mortality, even in women." According to his estimates, in the United States, 42.8 per cent of the deaths from cancer occur as the result of this disease affecting the stomach.

So far as Great Britain is concerned the general conservative estimate of most authors is that one-third of all cancers in men and one-fifth in women are primarily situated in the stomach. It is correct to say that even after making allowances for the increased expectancy of life and for more accurate diagnosis, cancer in general and cancer of the stomach in particular are yearly becoming more frequent.

Age and Sex Incidence. Most authorities state that gastric cancer is most frequently seen between the ages of 40 and 70, but more especially between 55 and 65. Fully 80 per cent of cases occur within this 10-year period. A number of cases are recorded as having been observed in infancy and adolescence. In England and Wales between the years 1921-1930, inclusive, four cases of under 5 years of age were notified, while in the 5-year period, 1931-1935, there were no



a



b



c



d

FIG. 86.—CANCERS OF THE STOMACH.

(a) leather-bottle stomach.

(b) colloid cancer.

(c) ulcerating cancer of the pyloric region of the stomach.

(d) multiple polypi, some of which are undergoing malignant change.

fewer than 68 deaths from cancer of the stomach occurring in patients under the age of 15. Hartley (*Tr. Med.-Chir. Soc. Edinb.*, 185, 1937) considers that there is no intermediate peak period in the occurrence of the disease, but that its incidence increases as age advances so that in the adequately corrected figures the highest rate of occurrence is at the end of life, in the decade of 75 to 85. He writes:

It will be observed that the death-rate rises steeply from the age of 35. In actual numbers, the maximum period is between 65 and 75, but corrected from the numbers living in the various age groups, the rate continues to rise and has its peak in the decade 75-85. In other words, the liability to cancer of the stomach does not diminish after 75, but increases and reaches the maximum in the decade 75-85. . . . An interesting feature is the relative incidence in males and females in the various age periods. From 45-65, the male incidence is much higher than it is in the female—almost 5:3. After the age of 65 the ratio becomes equal and eventually the female incidence is larger than it is in the male. In my own series the proportion was 36 females to 83 males. This is partly but not entirely accounted for by the low number of patients operated upon over the age of 70.¹

Heredity. Gatewood found a heredity predisposition in 11 per cent of his patients; Minnes and Geschickter in 12.7 per cent; Balfour in 16 per cent; and Thiele in 23 per cent. In 100 consecutive cases investigated by me I found a definite family history in 26, and it would appear that in certain families at any rate there is a hereditary tendency to the disease.

Predisposing Factors.—*Chronic Gastritis.* Konjetzny (*Monatschr. f. Krebs.*, 2:65, 1934) believes that cancer never develops in a previously healthy stomach and that chronic gastritis is the most important predisposing factor. He is supported in this view by Hurst (*Brit. M. J.*, 2:665, 1934) who holds that achlorhydria, which is so frequently observed in cases of gastric cancer, is caused by gastritis and not by the presence of the neoplasm. In a significantly large number of cases of ulcer-cancer Hurst found free hydrochloric acid to be present, but when there was no evidence of a previous peptic ulcer, hydrochloric acid was usually absent, even in the early phases of the disease. He states that if a patient with a constitutional predisposition to cancer also has achlorhydria and gastritis, he will probably develop cancer of the stomach but that the early diagnosis and

¹ Hartley, *Tr. Med.-Chir. Soc. Edinb.*, 185, 1937.

treatment of the gastritis will diminish the frequency of gastric carcinoma.

Walton considers that Hurst's work is very suggestive, but if his theory is true it would indicate that chronic peptic ulcer of the stomach is a more common cause of cancer than is usually believed. As some degree of chronic gastritis is found in all gastrectomy specimens when resection is undertaken in intrinsic gastric lesions, this view is difficult to disprove. Some pathologists, however, regard gastritis as a secondary manifestation resulting from the presence of the growth.

Chronic Gastric Ulcer. All authorities are agreed that in a certain proportion of cases cancer arises in a chronic gastric ulcer. A study of statistics does not help me to state the exact percentage of gastric ulcers which turn into cancer or the number of cancers which are superimposed upon ulcers. The estimate varies from 1 to 70 per cent! An important consideration is that whatever the percentage, some ulcers end as cancer and some supposed ulcers are cancers from their inception. Stewart, whose work on this subject deserves the highest praise, in a specially investigated series of 259 gastrectomy specimens, found that 15.7 per cent of cancers arise in chronic peptic ulcer. All observers are agreed that the position and the site of an ulcer in the stomach is of the greatest significance as regards its possible malignancy; thus, a chronic ulcer situated on or within half an inch or so of the greater curvature, even when it possesses all the radiological appearances of a benign ulcer, should be regarded and treated as malignant. Ulcers occurring in the pyloric segment should always be viewed with suspicion, as fully 30 per cent of these are primarily malignant ulcerating growths. The large indolent penetrating ulcer occurring on the posterior wall near the lesser curvature should in most instances be treated by partial gastrectomy, since some 20 per cent of these will show malignant changes when submitted to microscopical investigation. It is an excellent rule to regard as malignant all chronic ulcers of the stomach that have a diameter of one inch or more.

Innocent New Growths of the Stomach. All benign gastric tumours are liable to undergo malignant degeneration, but this applies particularly to adenomata (see page 488).

Other Possible Factors. The causes of cancer remain as yet

shrouded in mystery, but constant or intermittent trauma or irritation of the mucosa, such as might be produced by unsuitable articles of food, very hot or iced drinks, over-smoking, excessive consumption of alcohol or of certain well-known beverages, constant nervous strain, a lack of vitamins (and especially vitamins A and C), severe chronic intoxication, the obscure and little detected ravages of acute specific or infectious disease, or congenital absence of free hydrochloric acid in the gastric juice, have at various times been thought to predispose to cancer of the stomach.

PATHOLOGY

Of malignant tumours of the stomach 99 per cent are carcinomata. Microscopically, the cells in carcinoma may be columnar, cuboidal or round, and they may vary considerably in size. Their arrangement is either tubular or acinar—adenocarcinoma, or in solid clumps—carcinoma simplex. Mucinous, gelatinous or colloid degeneration is a common feature. Growths situated at the lower end of the œsophagus—squamous carcinoma—may also invade the stomach and project into its lumen. Macroscopically, growths of the pylorus and cardia are densely hard and fibrous, while those of the body are soft, fungating and luxuriant. The naked-eye appearance of the disease may show wide variations, but three common types of growth are well recognised:

1. The malignant ulcer.
2. The fungating polypoid tumour.
3. The leather-bottle stomach, or linitis plastica.

Malignant Ulcer. The ulcerative carcinoma of the stomach is the most malignant and is the commonest type seen (fig. 86 [6]). These growths occur most frequently in the pyloric segment or in the region of the lesser curvature although no portion of the stomach is immune. They infiltrate widely and rapidly and soon give rise to metastases of the regional lymph nodes and in the liver. The growth is scirrhus in nature, is composed of spheroidal or columnar cells in an abundant matrix of connective tissue, and is prone to undergo mucinous degeneration. The ulcer is usually oval or circular in shape, has a firm, raised, rampart-like or rolled-over edge, and a shallow crater, the floor of which is often superficially ulcerated or necrotic. At times the

punched-out appearance of a chronic gastric ulcer may be closely mimicked, and a gastric ulcer which becomes malignant is of this variety.

When a section is made through the growth, it will often be possible to trace the muscular layers across the base of the ulcer, even in those cases where the muscle and serosa have been extensively invaded by growth. On the other hand, a section through a gastric ulcer which is undergoing malignant change will show a complete breach or obliteration of the muscular layers, the floor of the crater being composed of dense white fibrous tissue which forms an insurmountable barrier against invasion by cancer cells.

The growth spreads rapidly in the submucosa, but less quickly beneath the tough serosa away from the pyloric ring toward the cardia, while outlying islets can be detected at least half an inch in advance of the growing margin. When the growth extends to the peritoneal coat of the stomach, the overlying surface of the organ may become studded with minute white pearly seedlings, wrinkled or puckered, greatly thickened, œdematous, and opalescent from gelatinous degeneration or converted into a disc-like plaque of metallic hardness, from the vicinity of which arise rigid filamentous strands or knotted cords of permeated lymphatic vessels.

Fungating and Polypoid Tumours. These form bulky, friable, cauliflower-like masses or rounded soft tumours with broad pedicles which project into the lumen of the stomach. They usually arise in the body of the stomach, in the region of the greater curvature, posterior wall or fundus, and are at first of a low order of malignancy. They give rise to but few symptoms during their early stages of growth, but may by their fleshy bulk plug the outlet of the stomach and cause pyloric obstruction. They are prone to become infected, to slough and to ulcerate, and when they do so, bleeding and the effects of bleeding will be striking features.

The fungating tumours are adenocarcinomata and are composed of columnar epithelial cells. The regional lymphatic glands are invaded late in the course of the disease, and infiltration is confined to a limited area of the stomach wall. A number of these growths originate in innocent tumours—polypi.

Leather-Bottle Stomach—Linitis Plastica. Two forms are described: the local and the diffuse.

The *local* form of the disease starts at the pylorus, spreads slowly in the direction of the cardia and is associated with much fibrosis. The duodenum itself is rarely involved. The pyloric canal may in certain cases become constricted by the enormous overgrowth of fibrous tissue which occurs in the submucous coat and by the accompanying congestion of the overlying mucous membrane, resulting in marked dilatation of the stomach. When this takes place the condition is often termed chronic scirrhus cancer of the pylorus, and it is, in fact, difficult to differentiate between the local type of linitis plastica and the chronic sclerosing carcinomata of the pyloric region (fig. 87). In the more typical forms of linitis plastica, however, it is more usual to find the uninvaded portion of the stomach collapsed and the pylorus patent. On examination the pyloric region is found to be greyish in colour, thickened, rigid, densely hard and inelastic. A section of the stomach shows the mucous membrane to be swollen and thrown into prominent folds and all the coats to be enlarged and the muscular layer hypertrophied, pale and fragmented. It will be seen that the thickening affects chiefly the submucosa, which is replaced by a hard mass of white fibrous tissue. In this tissue layer are a few sparsely scattered clumps of malignant spheroidal epithelial cells which prove very difficult to detect on microscopical examination of serial sections of the growth.

The following conditions may be mistaken for and may, in fact, on naked-eye examination be indistinguishable from the localised form of linitis plastica: (1) hypertrophic tuberculous disease of the pylorus; (2) syphilitic gummatous infiltration of the antrum and pylorus; (3) simple pyloric fibrosis; (4) scirrhus cancer of the pylorus.

As it is often impossible to make any distinction between localised leather-bottle stomach and one or any of the above diseases when encountered at operation, it is a safe rule to perform gastrectomy on all suspicious cases on the assumption that the leathery pyloric tumour is malignant.

The *diffuse* form of leather-bottle stomach was first described by Brinton in 1854, and is a rare type of cancer. He considered that the name linitis plastica was very apt and very descriptive of the thick-walled contracted organ. Like the localised type, it starts at the pyloric ring, infiltrating the submucosa and subserosa, growing slowly

around the circumference and along the longitudinal axis of the stomach toward the cardia. While the growth ends abruptly at the pylorus and only on the rarest occasion involves the duodenum, it will in time advance upward toward the œsophageal opening and actually invade the lower reaches of the gullet. The stomach eventually becomes steernhorn in shape and is shortened and contracted by several inches. It is transformed into a leathery, rigid tube, incapable of being distended, so that its capacity is reduced to a few ounces. The mucous membrane is swollen and markedly rugose, these hypertrophied rugæ appearing to be welded to the underlying submucosa. A few shallow ulcers, irregular in shape, may be present, but in most cases the surface of the mucous membrane is unaffected. The pyloric and cardiac orifices become fixed and patulous and all sphincteric control is lost. The serosal aspect of the stomach is usually of a greyish-brown colour, although occasionally it may present a normal appearance.

A section of the stomach wall shows that the thickening consists mainly of white fibrous tissue and involves chiefly the submucosa and subserosa. The walls of the stomach may be as much as an inch thick. The fragmentation of the muscular layer is strikingly apparent, being produced by fibrous septa which extend upward from the submucosa to the subserosa and divide up the thickened circular muscular coat into little separate bundles (fig. 86 [A]).

A specimen of linitis plastica may sometimes present the appearance of a stomach which has been fixed in a strong solution of formalin for a considerable period. Metastases occur in the adjacent lymph nodes late in the course of the disease, and as this type of cancer is slow-growing and the growth is confined to the walls of the stomach itself for a long time, total gastrectomy is indicated whenever conditions permit of the performance of this extensive operation, as, when this procedure is successful, life may be prolonged by a few valuable years.

Modes of Extension of Gastric Carcinoma

The six principal routes of spread are: (1) In the stomach wall; (2) in the duodenal walls; (3) to neighbouring lymph glands via the lymphatic vessels; (4) to adjacent organs via adhesions, neighbouring

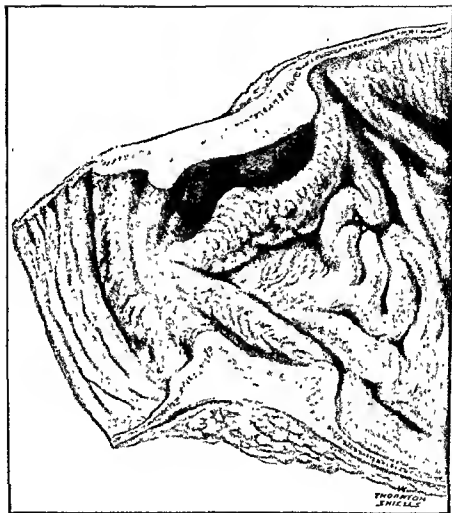


FIG. 87.—CHRONIC SCLEROSING CARCINOMA OF THE PYLORIC REGION:
GASTRECTOMY SPECIMEN.

viscera, or to the abdominal parietes; (5) to distant organs via the blood stream; (6) by the peritoneal cavity.

In the Stomach Wall. The main line of spread is upward along the lesser curvature and to a lesser extent along the greater curvature toward the cardia. The growth spreads mainly in the submucous coat, and in the infiltrating type of cancer of the stomach such spread is rapid and very diffuse. The infiltration of this coat is usually one inch or more in advance of the visible growing edge. The microscopical extent of the growth may therefore be extensive and some distance away from the visible and palpable margin, as Verbrugghen has so ably shown.

In the ulcerated types, outlying nodules or numerous small groups may be seen scattered in irregular arrangement just beyond the advancing edge of the tumour. The cancer involves the muscular coats lying deep to its site of origin, and splits up the muscle into pale pink blocks. This is well seen when a section is made through the growth. The segmented muscle bundles are separated by strands of white fibrous tissue and carcinoma which run at right angles to the serosa. Occasionally, the septa are arranged longitudinally, when alternating layers of pale pink muscle and white growth can be seen. When the serosa is breached, cancer cells become detached from the parent growth and profusely inseminate the whole of the peritoneal cavity with malignant cells.

In the Duodenal Wall. The oft-repeated statement that malignant growths of the pylorus very rarely invade the duodenum is, of course, not true. Involvement of the mucosal coat occurs quite frequently, and I have specimens which clearly show pyloric growths extending through the gastric outlet and implicating the duodenum.

When performing a radical sub-total gastrectomy for cancer of the stomach it is most important to include the major portion of the first part of the duodenum in the resection in order to make certain that the distal line of section is placed well beyond this likely avenue of invasion.

To the Lymphatic Glands. In about 80 per cent of cases of cancer of the stomach metastases occur in the lymphatic glands, either at an early or late stage of the disease; but in some 20 per cent of cases the lymphatic glands do not at any stage become involved in growth. The position and extent of the glandular involvement is in part

dependent upon the size, the position and the nature of the malignant tumour, but a large growth may sometimes be present with little or no metastatic implants in the glands, while a small sessile carcinoma may be associated with widespread metastases in the lymph glands. Again, in diffuse leather-bottle stomach the lymph glands may not be involved, or only at a late stage of the disease. In scirrhus growths of the pylorus, the adjacent group of glands, *i.e.*, the supra-, the retro- and the infra-pyloric, and even the lower coronary glands situated on the lesser curvature, very soon become involved, making the prognosis in these growths poor in comparison with those situated a little higher up in the body of the stomach.

Again, when a carcinoma is situated in the upper half of the lesser curvature, the glands in this region, *i.e.*, the upper coronary groups and paracardial glands, are invaded at an early date, whereas in cancer of the middle third of the lesser curvature, although the lower and upper coronary groups may show early metastases, provided the tumour is mobile and the glands are easily accessible, gastrectomy is followed by a high percentage of encouraging results.

The involvement of lymph glands is least when the growth is situated on the anterior wall of the stomach, on the greater curvature or in the region of the fundus. Ulcerating carcinomata metastasise rapidly and extensively, whereas the polypoid growths and the leather-bottle stomach do not readily involve the regional lymph nodes, and when such involvement does occur their spread is more limited and less eager.

If the glands in the portal fissure become involved with carcinoma, they may press upon and occlude the bile passages, giving rise to obstructive jaundice. Growth occasionally spreads along the ligamentum teres toward the umbilicus, where it may form a hard knobby tumour. Invasion of Virchow's sentinel gland in the posterior triangle takes place via the thoracic duct in late cases, and in probably less than 1 per cent of such cases the glands in the left axilla also show evidence of metastatic deposits.

Enlarged glands found at operation for malignant disease of the stomach are not necessarily cancerous, and in a number of cases they are simply inflammatory. Inflammatory glands are often enlarged and soft, elastic, pink in colour, and discrete, whereas malignant glands may or may not be enlarged, are often irregular in shape, hard and

shotty, with whitish deposits, and sometimes matted firmly together. Permeated lymphatic vessels often stand out as small knotty cords.

To Adjacent Organs. Growth in the stomach may involve neighbouring viscera by direct spread. The organs most frequently invaded are those which lie near the stomach, such as the colon, pancreas, liver, gall-bladder, duodenum and upper coils of the jejunum. The spleen is but rarely affected. Spread to these viscera may also occur along adhesions, membranes, or through the medium of the omenta. The great omentum, when extensively involved in growth, sometimes forms a huge, mobile, discrete abdominal tumour which may confuse the diagnosis.

To Distant Organs via the Blood Stream. When malignant cells enter the blood stream, metastases soon occur in the liver, lungs, pleura and bones, under the skin as hard subcutaneous nodules, or in other parts of the body. Metastases in the liver form large white hard umbilicated tumours accompanied by enlargement of the organ and later by jaundice and ascites. They may closely simulate multiple gummata of the liver.

By the Peritoneal Cavity. When cancer has reached the peritoneal surface of the stomach, it implies that the case is inoperable, as malignant cells are soon freely discharged into the general peritoneal cavity and give rise to carcinomatosis and tumours in the pelvis. The pelvic peritoneum may become studded with growth, or large masses may form here owing to the cells gravitating downward. It is these deposits in the pelvic shelf which may be felt on rectal examination in cases of inoperable cancer of the stomach. The stomach is one of the commonest organs to give rise to general dissemination of growth over the peritoneum.

Ovarian metastases occur in 3 per cent of cases. These ovarian tumours may be mistaken for primary growths of the ovary and may on microscopical examination resemble a Krukenberg tumour (fibrosarcoma muco-cellulare). In every case of bilateral malignant disease of the ovaries, therefore, the stomach should be carefully examined at exploratory operation for any evidence of primary growth in this organ.

Signs and Symptoms

The clinical features are for the most part dependent upon the situation, the extent and the type of the growth. In its early stages, cancer of the stomach gives rise to little constitutional disturbance. Cancers situated at the inlet or outlet of the stomach are associated with mild dyspeptic symptoms before they declare themselves and before they produce symptoms attributable to obstruction. Growths occurring in the body of the stomach may be clinically silent to the end or may be marked by vague symptoms such as lassitude, epigastric uneasiness, etc., until a late stage in the disease has been reached. A large polypoid cancer arising on the greater curvature by a stout stalk may grow exuberantly for a long time without giving any warning of its presence until it unmasks itself with dramatic suddenness by bleeding profusely or by blocking the pylorus with its fleshy body.

There is also a lethal type of cancer of the stomach which may masquerade as a chronic gastric ulcer for many months. It may be associated with periodic bouts of indigestion and even with hunger pain. It may show a temporary satisfactory response to medical treatment; the patient may actually gain in weight and in strength for a time, the X-ray pictures may reveal evidence of healing, occult blood may disappear from the stools, and all the laboratory tests may firmly support the diagnosis of peptic ulcer. With such an ulcerating cancer it is, nevertheless, only a question of time before its true character is revealed.

The fact that one type of lesion will often produce different symptoms in different individuals and that various dissimilar lesions can cause similar symptoms adds greatly to the difficulties in diagnosis. There are no pathognomonic symptoms of early cancer of the stomach, although there may be dozens of "syndromes," and the so-called classical clinical manifestations are usually those of the inoperable—or at least of the advanced—stage. The early symptoms considered individually can mean anything or nothing, and they may not point to the stomach at all, let alone to gross disease of the stomach.

While it is agreed that certain cancers of the stomach may be associated with anomalous vague and bizarre clinical phenomena, it is nevertheless possible in a number of cases to recognise three common clinical types:

1. The insidious or common type.
2. The obstructive type.
3. The gastric ulcer type.

The Insidious Type. Cases in this group cause considerable difficulty in diagnosis on account of the vagueness of the inaugural symptoms. This is chiefly due to the position of the growth in the capacious body of the stomach and to the fact that there is little if any interference with gastric function in the early stages of invasion. The first manifestations of such growths may, however, be an alarming hæmatemesis, melæna which bleeds the patient white, or an acute perforation which immediately threatens life.

On the whole, the early symptoms in this insidious type, when grouped together, are very insignificant, at least to most of us, and they may only suggest that the patient is suffering from debility, from anæmia, from an unaccountable loss of weight, or from a mild form of indigestion, or that he is in special need of a tonic or of a holiday.

The *initial* symptoms usually comprise: (a) *The fatigue syndrome*. This would include lassitude, loss of energy, malaise, so-called gastric influenza, mental apathy, and loss of interest. (b) *A recently-developed stomach consciousness*, a vague feeling of discomfort or oppression after meals, a mild but persistent dyspepsia, a sensation of fullness or of weight in the epigastrium after eating, gastric flatulence, etc. (c) *Anorexia*. This is mild in the early cases, there being a gradually increasing loss of appetite. (d) *Nausea*. This may be the first symptom of gastric cancer, and appears to be aggravated first thing in the morning before breakfast and after a full meal. (e) *Change in bowel habits*. In the early stages of cancer of the stomach the patient is usually constipated; in the late stages, diarrhœa is common—gastrogenic diarrhœa. (f) *Pallor*. A slight anæmia of unexplained origin should arouse a suspicion of cancer of the stomach. Dyspnœa, which is present in some cases, is often due to anæmia. (g) *Loss of weight*. Persistent and gradual loss of weight often occurs in the early stages, but it is not safe to assume that gastric carcinoma is absent because the patient's weight is stationary.

The *late* symptoms include: (a) *Abdominal pain*. This is always a variable factor. In cancer of the stomach pain may be mild or severe, constant or remittent as in cases of peptic ulcer, relieved or aggravated by food, appeased by vomiting or gastric lavage, of a dull con-

tinuous aching nature, or may occur only as short bouts of severe colic or be of an unremitting racking intensity. It should be noted that as the cancer progresses the epigastric discomfort or uneasiness becomes more marked and more constant, gradually merging into the stage of incoercible pain. Nocturnal pain is more constant in cancer of the stomach than in most other abdominal lesions. (b) *Vomiting*. This is usually a late symptom but may be an early feature in pyloric and cardiac growths. (c) *Hæmatemesis*. The vomiting of blood is a rare complication, occurring in about 5 per cent of cases. Like melæna, it is often a late manifestation. (d) *Cachexia*. This denotes that the lesion in the stomach is advanced. The lemon-tinted skin and marked pallor which so frequently accompany cachexia are signs of the gravest import. (e) *Marked anorexia*. This, especially when progressive and associated with repugnance for food, and particularly meats, is very suggestive of growth of the stomach.

In the early stages nothing may be detected on early examination, although the expert clinician will often pay more attention to the general appearance of the patient than to a large number of disconnected and trivial symptoms. The patient may look well or may appear a trifle pale or worn. On palpation of the abdomen there may seem to be nothing amiss or there may be a suspicion of some tenderness or rigidity in the epigastrium on firm pressure. Even a large growth may be impalpable when the stomach lies collapsed and hidden under the cover of the liver or ribs. Hunt (*Brit. M. J.*, 1:650, 1935) has stressed how important it is to examine these patients in the upright position. When the patient is examined in this position the searching fingers may often palpate a small growth of the stomach which might be missed by palpating the suspected area with the patient in the horizontal position.

It should be remembered that a large growth of the body of the stomach may remain localised for a considerable period whilst a small pyloric cancer, which at no time becomes palpable, may first declare itself by the presence of metastases in the liver. The size of the tumour is, of itself, no indication as to operability or of the presence of metastases; in fact, some of these large palpable tumours lend themselves very readily to resection, whereas some of the infiltrating small growths of the pylorus may be associated with widespread implants not only in the regional lymph glands but in the omentum and

peritoneum. Minnes and Geschickter (*Am. J. Cancer*, 27:740, 1936), in examining 541 patients found 236 (43.6 per cent) who had a readily palpable mass in the epigastrium. This figure conforms closely to that reported by most authorities. In Lahey's series there were 28 per cent of palpable growths. In some 5 per cent of cases the patient himself is actually aware of the presence of an epigastric tumour.

The Obstructive Type. Symptoms in this type vary according to whether the growth is situated at the œsophageal orifice or at the pylorus. Features common to both types are associated with obstruction. If the growth occurs at or near the *cardiac orifice*, the patient complains of increasing dysphagia, first with solid food and later with fluids, and the condition may be exceedingly difficult to differentiate from cancer of the lower end of the œsophagus. Loss of weight is excessively rapid as soon as the growth encroaches upon the narrow inlet of the stomach, but even before this channel is constricted there is a steady weekly or possibly daily reduction in weight.

When the *pyloric portion of the stomach* is the seat of cancer, the symptoms are those of pyloric stenosis, and it is often quite impossible to determine by the symptoms alone whether obstruction is due to growth or to ulcer (see page 489).

The Peptic Ulcer Type. About one quarter of the patients with cancer of the stomach give a history of peptic ulcer which has existed for many years prior to the discovery of the present trouble, and many of these patients are primarily treated by medical measures for chronic gastric ulcer.

The point at issue, and it is a purely clinical point, is that some patients with a definite ulcer history, with a radiological diagnosis of ulcer, with laboratory findings typical of ulcer, with all the clinical and scientific evidence in favour of ulcer, prove the utter unreliability and worthlessness of that evidence by dying of cancer. When or where or how the malignancy originated may interest the pathologist, but it is not of the smallest interest to the clinician who made the mistake and to the patient who paid with his life for the error.²

The pre-operative differentiation between a gastric ulcer and ulcerating carcinoma is impossible in certain cases, even after a trial by therapeutic tests and repeated investigations by means of a gastro-scope. Even at operation it is often quite impossible to make any

² Maes, Boyce and McNettridge, *Ann. Surg.*, 619, 1933. Courtesy of J. B. Lippincott Co.

confined to the mucous membrane, and the muscular coat being thus uninvolved the typical peristaltic waves may be seen to pass unchecked across the malignant zone.



FIG. 88.—CARCINOMA OF THE STOMACH, SHOWING THE "FINGER-PRINT" TYPE OF FILLING DEFECT (BULL).

Early cases of leather-bottle stomach, growths of the greater curvature, and cancers of the fundus are elusive, and by presenting atypical and indeterminate appearances lead to misinterpretation and a delay in diagnosis. Negative X-ray findings do not prove the absence of malignant growth, nor should a decision as to operability be based solely upon the radiological findings. A large growth which on screen-

ing appears to be fixed, may, nevertheless, prove resectable on exploratory operation. Hauser and Pack (*Radiology*, 26:221, 1936), in an excellent review, are of the opinion that the radiological signs of cancer of the stomach may be concisely summarised as follows:



FIG. 89.—CANCER OF THE PYLORIC SEGMENT OF THE STOMACH (BULL).

1. Filling defects (figs. 88 and 89).
2. Altered pyloric function: (a) gaping of the pylorus; (b) obstruction of the pylorus (fig. 90).
3. Advanced position of the 6-hour meal—hypermotility.
4. Absence of peristalsis from involved areas of the wall of the stomach.

5. Diminished mobility; loss of flexibility.
6. Diminution of the size of the stomach (fig. 91).
7. Anti-peristalsis.
8. Niche in the pre-pyloric region within 2.5 cms. of the pylorus.

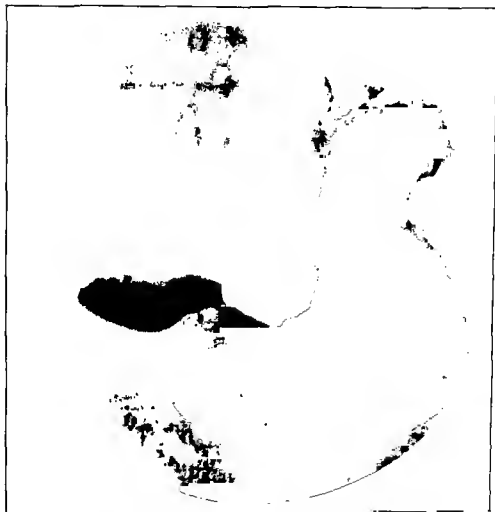


FIG. 90.—CANCER OF THE PYLORUS, PRODUCING OBSTRUCTION.

This is the so-called "pipe stem" type (Bull).

9. Widening of the space between the gas bubble in the cardia and the top of the diaphragm.
10. Soft tissue densities in the cardia outlined by the gas bubble; no contrast meal.

11. The "meniscus" sign.
12. Absence of rugal markings.
13. Niche in relief studies without radiation rugal lines.
14. Niche in the greater curvature.



FIG. 91.—LEATHER-BOTTLE STOMACH OR LINITIS PLASTICA.

A complete examination of the blood is made in every case, and varying degrees of anemia are noted. The anemia is of the secondary type, although on rare occasions pernicious anemia may be associated with a malignant growth in the stomach.

A gastrosopic examination is of the greatest value, particularly in

doubtful cases or where X-rays fail to reveal the presence of a filling defect in the stomach.

Ruddock (*Surg., Gynec. & Obst.*, 65:623, 1937), in a most illuminating article, advocates *peritoneoscopy* as a useful additional method of diagnosis. He considers that peritoneoscopy should be selected in lieu of diagnostic laparotomy where it is necessary to determine malignancies, metastases, and extent of involvement, to differentiate tumour masses and localise them, to examine the surfaces of viscera and pelvic organs, or to corroborate a diagnosis or to obtain biopsies. He is of the opinion that the very practical results of this relatively simple method of examining the contents of the abdominal cavity with the eye should command for it, as a diagnostic procedure, the general use which the cystoscope now holds for the examination of the bladder (fig. 92).

In cases of limited ulcerating lesions of the body of the stomach or of the pylorus where it may be thought that the condition is benign, the therapeutic test, i.e., the trial by medical treatment, should be advocated. This consists of putting the patient to bed to ensure complete rest, and instituting a strict and careful regime of medical treatment. If at the end of three weeks the symptoms have disappeared, the ulcer has appreciably diminished in size, and occult blood has vanished from the stools, a further course of this treatment should be given until there is no X-ray evidence of ulcer. If, however, the symptoms do not entirely disappear and the ulcer shows no sign of regression, exploratory laparotomy should be advised.

Clinical Signs of Inoperability. It is good practice to follow the rule that in cases of cancer of the stomach exploratory laparotomy should be undertaken unless recognisable, irremovable metastatic deposits can be demonstrated. Provided metastases are not found on examination, the patient should always be given the benefit of the doubt, even though the disease may appear to be advanced.

As previously stated, the operability of a case cannot be judged merely by the size of the tumour. With large movable growths, where resection is often possible, the late results are sometimes surprisingly good. The massive fungating growths of the body of the stomach, which so frequently produce large epigastric tumours, metastasise late and sparingly, are locally malignant for long periods and often lend themselves to subtotal gastrectomy.



Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.

Fig. 1. Carcinoma metastases in liver. Note the metastatic implantation on under side of diaphragm. View as obtained through peritoneoscope.

Fig. 2. Fibromyoma of uterus viewed through peritoneoscope.

Fig. 3. Ovarian cyst viewed through peritoneoscope.

Fig. 4. Papillary cystadenoma of ovary with peritoneal implantations viewed through peritoneoscope.

Fig. 5. Intra abdominal adhesions. Note how adhesions between omentum and parietal peritoneum are stretched by the production of pneumoperitoneum. Viewed through peritoneoscope.

The case should be considered inoperable if:

1. Hard tumours or plaques of secondary growth are felt per rectum or per vaginam in the pelvic peritoneum.

2. Virchow's gland in the neck is stony hard, enlarged and adherent to the surrounding structures.

3. Nodules of growth are present at the umbilicus.

4. Subcutaneous nodules of growth can be detected.

5. Ascites is present. This may occur with metastases in the liver, peritoneal carcinomatosis, or by obstruction of the portal vein by enlarged malignant nodes. Ascites, due rather to a severe anæmia than to metastases in the liver, may be present in a small number of cases of gastric carcinoma in which, at operation, the growth, nevertheless, proves to be resectable.

6. The liver is enlarged and nodular from secondary implants. Operation should never be advised if there is irrefutable evidence of secondary growth in the liver, even though the clinical and radiological findings strongly suggest that the growth in the stomach is resectable.

7. There is X-ray evidence of involvement of an extensive area of the stomach by growth and wide fixation of the organ to surrounding structures. A large *fixed* growth of the stomach is usually inoperable. However, in such cases, laparotomy may be justifiable, especially if there is no clinical proof of the existence of metastases and if the patient's general condition is tolerably satisfactory.

Differential Diagnosis. Cancer of the stomach has to be differentiated from other conditions which cause debility, anæmia, loss of weight and indigestion. Cancers of the cardia may be mistaken for growths or peptic ulcers of the lower end of the œsophagus, while tumours of the pylorus may be confused with benign ulcerations. The palpable gastric cancer must be distinguished from carcinoma of the colon, other forms of intra-abdominal malignant disease, cirrhosis, tuberculous peritonitis, ovarian cyst, etc. The so-called nervous dyspepsias, which are so commonly associated with anorexia, nausea, exhaustion and loss of weight, can only be correctly diagnosed after the most careful screening of the stomach. It is well to remember that nervous symptoms are often superimposed upon organic disease. In pernicious anæmia, the deathly pallor is suggestive of growth, but in the former disease anorexia is often absent, there is

little if any loss of weight, and indigestion is, as a rule, only slight. The blood picture is, of course, conclusive, but it should be remembered that the two diseases may co-exist.

Chronic gastritis from oral sepsis, alcoholism, indiscretions in diet, or after acute illnesses such as influenza, can be diagnosed with certainty only after the exclusion of gastric carcinoma by radiology and gastroscopy. A satisfactory response to medical treatment is not a valuable guide in these cases, since similar improvement may be observed for a time with cancer of the stomach. Innocent new growths of the stomach, gastric polyposis, hypertrophic gastritis and gastric syphilis have all to be considered in the differential diagnosis.

The inaugural symptoms of chronic cholecystitis are in many respects identical with those produced by a small malignant tumour of the stomach.

Causes of Delay in Diagnosis. Why is it that 50 per cent of cases are inoperable when seen for the first time, and that in only some 25 per cent can any attempt at cure by gastrectomy be made? What is the reason for delay in diagnosis?

1. The insidious nature of the disease may cause delay in diagnosis. The growth in the stomach is usually well advanced before it is manifested clinically by even the mildest symptoms.

2. The patient may be at fault. He is certainly to blame when he ignores the mild but persistent initial abdominal symptoms or dreads investigation fearing to be told that he is suffering from a cancer of the stomach and that an operation—and often a dangerous one—is necessary; when he considers that the present ulcer attack, although more stubborn and differing in many respects from previous attacks, will, by the old tried methods of dieting, alkaline powders and advertised remedies, eventually resolve as previous attacks have done; when although fully conscious that he is suffering from a serious gastric malady he yet fails to attend to his health for business, financial or other reasons: when he can feel a tumour in his abdomen, but keeps this sinister fact to himself, whereas if he sought medical advice at an early stage of the disease radical operation and hopes of cure might prove possible. No blame for delay can be attributed to him, however, when, although harbouring a cancer in his stomach, he feels comparatively well, or when, in the absence of gastric symptoms or in the presence of only slight discomfort, a sensation of full-

ness after meals, he immediately reports to his medical attendant, only to discover that, unknown to him, there is a cancer in his stomach which has already reached an inoperable stage.

3. Failure on the part of the medical attendant to recognise the significance of the early symptoms of cancer of the stomach. The practitioner is responsible when he does not fully investigate at the earliest possible moment every case of chronic dyspepsia which comes to him for treatment, when he fails to bear in mind that there is a potential cancer in the stomach of every patient, especially after the age of 40, who for the first time in his life complains of indigestion; when he treats cases of chronic gastric ulcer by medical measures indefinitely without submitting them to periodical radiological investigations, and when he overlooks the possibility of gastric cancer in all anomalous chronic abdominal conditions.

4. A lack of skill on the part of the radiologist. The radiologist is occasionally at fault for delay in diagnosis when he does not, in spite of his penetrating means of vision, detect or at least suspect a growth of the stomach when it is present, or when he mistakenly diagnoses the niche of a malignant ulcer as that of a simple gastric ulcer. It is, however, to be admitted that it is only on rare occasions that a competent radiologist will make a mistake in diagnosis in the presence of this disease, especially if he frequently re-examines all cases which are radiologically or clinically suspicious.

I am very sceptical whether an intensive educational campaign of the public concerning the ominous nature of mild abdominal symptoms in those individuals of the cancer age (40 to 65) will yield any better results than obtain at the present time. It is certainly significant that Alvarez (*J. Am. M. Ass.*, 97:77, 1931), who analysed 41 cases of cancer of the stomach in doctors, found that the duration of symptoms was not less in this enlightened group of patients than it was among the laity.

Patients with abdominal symptoms almost invariably seek advice in the first instance from their family doctor. Much therefore depends upon his skill and intuition and his knowledge of the early signs and symptoms and anomalous syndromes of this dread disease. It would help him considerably if he were in a position to have his patients investigated without delay or inconvenience and at a minimum cost at a reliable and nearby diagnostic centre.

Curability

Cancer of the stomach can only be cured by surgical attack and the only way we can improve upon our results is to concentrate upon earlier diagnosis and at the same time to extend the scope of the radical operation.

What percentage of cases who have sought surgical aid are alive and well at the end of 5 years? The study of a large number of statistics would still leave one guessing, but I would estimate that the following is a fair average. The percentage of five-year cures for all operations is about 5 per cent; for all gastrectomies about 15 per cent; and for all gastrectomies surviving operation about 25 per cent. A study of the literature shows that there is no uniformity of opinion as regards operation rate, resection rate, and curability rate, but there is no doubt at all that where the operability is low the curability also will be low and the mortality high. The results, as published by Balfour, Gatewood and Finsterer, are surprisingly good, and represent the acme of surgical achievement; but the figures recorded by the majority of other leading surgeons are depressing in the extreme. Balfour (*Collect. Papers Mayo Clinic*, 23:80, 1931) states that resection was possible in 43.16 per cent of his cases in which exploration was undertaken, and this represents 22.62 per cent of the patients who were seen with gastric cancer. He considers that the present situation is that in about 50 per cent of cases of cancer of the stomach exploration is warranted, and in about 50 per cent of these cases the growth can be removed. His figures thus prove that in less than 25 per cent of cases of cancer of the stomach can any attempt at cure be made by radical operation. He is also of the opinion that the mortality for partial gastrectomy should be less than 10 per cent. In the last 200 cases upon which he performed a partial or total gastrectomy for cancer of the stomach there were only 6 deaths—a mortality of 5 per cent. He reported a group of 278 patients who had lived five years or more following the removal of cancer of the stomach, stating that five-year cures could be obtained in 50 per cent of cases in which the regional lymph glands were not involved. No fewer than 128 patients with gastric cancer operated upon between 1910 and 1920 at the Mayo Clinic lived ten years or more, and this figure represents about 20 per cent of the total number of patients upon whom resection was

performed. Gatewood (*Surg., Gynec. & Obst.*, 21:42, 1933) reported a series of 417 cases of which 208 proved inoperable and 209 operable. In 30 per cent only an exploratory laparotomy could be performed; resection was possible in 122 cases, and among these there was a mortality of 18 per cent (22 patients). Of the 100 surviving patients, 46 per cent lived for over three years, 39 per cent lived for over five years, one patient (1 per cent) lived for over twelve years, one patient (1 per cent) was living at the end of sixteen years, and one patient (1 per cent) was living at the end of seventeen years. The average length of life following exploration was 6.1 months, after gastro-jejunostomy 8.17 months (2.07 months longer), while following resection the patients who left hospital had lived on an average of four years and nine months.

Finsterer's figures (*Wien. klin. Wchnschr.*, 1125, 1929) are interesting and may be grouped as follows:

1. Simple resections—211 cases. Of these 6.1 per cent died as the result of the operation, but 31 per cent lived for over five years.

2. Complicated resections—129 cases. In these there was a minimum mortality of 41 per cent, but of those who survived 30.4 per cent lived for over five years.

Gordon-Taylor (*Med. Press & Circ.*, 191:376, 1935) reported that in 108 resections for cancer of the stomach he had a mortality of 30 per cent, and of the 72 cases which survived gastrectomy 8 were alive and well after five years. He rightly considers that the operative mortality is not entirely an index of the efficiency or lack of efficiency of the surgeon's craftsmanship, but may, in fact, reveal his qualities of heart and his sympathy for the suffering.

Saint-John, Cheevers, Persson and Paterson all claimed that some 15 per cent of their patients who submitted to radical resection were alive at the end of five years; Bastianelli ("Rep. Internat. Cancer Conference," *Brit. M. J.*, 2:169, 1928) reported his personal experiences of 543 operations for cancer of the stomach. There were 239 resections with a mortality of 28 per cent, 176 gastro-jejunostomies with a mortality of 21.5 per cent, and 113 exploratory operations with a death-rate of 15 per cent. Bastianelli considers that there is hope of cure in 7 per cent of cases of gastric cancer. Walton (*Lancet*, 1:1101, 1936), who has the largest series of cases in England, found that of 461 cases radical operation was possible in only 173 cases. Included

in this latter figure were six total gastrectomies for leather-bottle stomach. His operability rate was 43.9 per cent, and his mortality 28 per cent.

Walton holds that a cure may be looked for in 6 per cent of all patients who come for operation, in about 16.5 per cent of those in whom resection is possible, and in about 23.5 per cent of those who survive resection. Minnes and Geschickter state that the high mortality of cancer of the stomach is seen in their series of 370 cases who were followed up after operation for more than five years or until death occurred. In their series there were only 3.5 per cent of five-year cures.

REPORTED CASES
(after Hartley)

Author	Operated Cases	Radical Operations	Mortality	Alive	Years						
					10	5	4	3	2	1	
Lahey	196	257%	31%	11		2	1	1	1	6	
Lewisohn . . .	263	93 (35%)	33%		3	7					
De Beule .	238	197 (76%)	63		1	3	1				
Ross	200	83 (41.5%)	31			6			2		
Persson	1150	361 (31%)	28%	..	18						
Gordon-Taylor		108	30%		1	8					
Balfour		45.50%	10%		20% of all 5 years						
St Thomas's Hospital ..	119	27 (18.1%)	33.3%		1			3		7	
					Over 10 yrs	7	6	5	1	3	1
Walton	461	167 (36%)	49 (28%)	28	5	1	3	7	1	4	3

These then are the published statistics. We have, on the one hand, the truly encouraging figures of Balfour, Gatewood and Finsterer,

and, on the other hand, the discouraging results obtained by a large number of eminent surgeons. It has been my experience that fully 50 per cent of cases when first examined are found to be inoperable owing to the presence of obvious metastases in the liver or in the pelvic shelf, to ascites, to jaundice, or to evidences of cancer as far afield as Virchow's gland. Of the patients deemed fit for exploratory operation 40 per cent are beyond the reach of any form of surgical treatment, 20 per cent admit of a palliative operation, and 40 per cent are suitable for partial, sub-total or total gastrectomy. Some 30 per cent of all patients with cancer of the stomach who are admitted to hospital die very shortly after operation. They do not nowadays die of shock, of hæmorrhage or of peritonitis; they drift into a drowsy state of coma and fade away. Those who have had a palliative gastro-jejunostomy performed obtain fleeting relief for about five to eight months at most, and it is common to find that such patients die quicker than those who are not operated upon at all, or who undergo merely an exploratory laparotomy.

Palliative gastrectomy or gastric exclusion after the method of Devine is an infinitely better procedure than gastro-jejunostomy. The relief is more complete and life is prolonged by many months, or in some exceptional cases for a year or so.

Treatment of Gastric Cancer

1. Management of the inoperable case.

2. Operative treatment:

(a) *Palliative operations*: (i) gastro-jejunostomy—anterior or posterior; (ii) exclusion of the growth—Devine's method; (iii) resection of the growth; (iv) gastrostomy—by the methods of Stamm, Witzel, Marwedel, Kader, Spivack or Depage-Janeway; (v) jejunostomy—Witzel.

(b) *Radical operations*: (i) Billroth I types of repair; (ii) anterior and posterior Polya methods, with modifications by Finsterer, Hoffmeister and Balfour; (iii) total gastrectomy.

Management of the Inoperable Case. Much may be done for these patients to relieve them of pain and obstruction and to treat anæmia, insomnia and dyspeptic symptoms. Pain may be due to the pressure of the growth upon neighbouring structures, to obstruction, to gas-

tritis, or to a combination of all three. The following measures are advocated:

1. *Diet.* In the late stages no solid food should be given, and nutrition should be maintained by the administration of fluids and semi-solids by the mouth. Regular 2-hourly feedings of 5 oz. of egg and milk, malted milk foods, arrowroot, vegetable cream soups, glucose, custard, jelly, junket, ovaltine, alcohol, barley water to which is added ten per cent glucose, etc.

2. *Medicines.* Simple alkaline powders or a mixture containing sodium bicarbonate, grs. 16, ammon. carbonate, gr. 1, glycothymoline, m. 20, ol. menth. pip., m. 1, infus. gent. co. ad $\frac{1}{2}$ oz., may be prescribed three or four times a day. Restlessness and insomnia are combated by the administration of bromides, nepenthe, tinct. opii. or tinct. chlorof. et morph. co. Anæmia is treated with ferri et ammon. cit., grs. 30 t.d.s. in milk, and by campolon, 2 ccm. injected every second day. Luminal, gr. $\frac{1}{2}$, or chlorotone, grs. 5, phenacetin, grs. 5, and caffeine, grs. 2, may be given to relieve pain in the early stages. Later on, when this mixture and others which have been tried prove ineffective and the patient is unable to bear the intolerable and unremitting pain with which he is tormented, the inestimable benefits of lavish doses of morphia, omnopon and scopolamine, or heroin should not be denied.

3. *Gastric Lavage.* This is urgently indicated in cases of pyloric stenosis in order to rid the stomach of its decomposing stagnant fluids and mucus, to relieve pain and colicky spasms, and to improve the general condition of the patient. It is also a very useful measure in relieving pain, even when no obstruction is present. A small stomach tube should be passed daily and the gastric contents aspirated. The stomach is then gently irrigated with normal saline, hydrogen peroxide (1 drachm to the pint), or a weak solution of hydrochloric acid. The irrigation should be continued until the contents are returned clear.

It is in these inoperable cases that the surgeon is always questioned as to the relative merits of X-rays and radium in so far as palliation is concerned. The present position in the treatment of cancer of the stomach by means of X-rays and radium is so ably discussed by Pack, Scharnagel, Quimby and Loizeaux that I venture to quote the summary of their findings:

- (1) Gastric cancer was the first type of tumour ever treated by roentgen rays.
- (2) The disadvantages of irradiation of gastric cancer are:
 - (a) the daily utilization of the stomach in feeding;
 - (b) the inaccessibility of the stomach and the consequent low tissue dose delivered by external irradiation;
 - (c) the danger of laparotomy for interstitial irradiation;
 - (d) the degree of radiation sickness following treatment;
 - (e) the extent of the cancer, as only inoperable gastric cancers are treated by irradiation; and
 - (f) the frequent obstruction of the cardia and pylorus by these cancers.
- (3) Less than 10% of gastric cancers exhibit any considerable degree of radiosensitivity. These rare radiosensitive cancers are usually situated in the cardia and fundus or on the greater curvature of the stomach.
- (4) There is a certain anaplastic small cell gastric cancer which bears a close morphologic resemblance to lymphosarcoma and is sensitive to radiation.
- (5) Gastric cancers have been treated by roentgen rays, radium element pack, interstitially implanted radium and combinations of these agents. The tissue dose delivered to the tumour in each case has been determined and expressed as skin erythema units. External irradiation is given through several ports to cross-fire at the stomach; the Coutard technic of fractionated dosage is the procedure of choice. The radium element pack is the most effective agent for external irradiation of gastric cancer.
- (6) We believe that there is little rational basis for irradiation of the barium-filled stomach. Several reasons are given that pre-operative irradiation of resectable gastric cancer is not advisable. Interval irradiation with two stage resection of carcinoma of the stomach has been employed for cancers of borderline operability situated in the distal segment.
- (7) Carcinomas of the cardia have been treated by the implantation of gold radon seeds in addition to external irradiation. The radon seeds are implanted through an endoscope inserted in an opening made by gastrostomy as well as through the seromuscular coat, after exposure of the cardia by resection or elevation of a left costochondral rib flap.
- (8) Inoperable pyloric and antral carcinomas are treated whenever possible by irradiation after gastro-enterostomy with exclusion of the cancerous distal segment of the stomach.
- (9) Postoperative prophylactic radiation therapy is reserved only for those operable gastric carcinomas which on histologic analysis are shown to be among the rare anaplastic radiosensitive tumours.
- (10) The possible complications of irradiation of gastric cancer are:
 - (a) radiation sickness;
 - (b) peritonitis;
 - (c) gastric hæmorrhage; and
 - (d) necrosis and the formation of fistulas with adjacent viscera.

(11) Radiation therapy is a palliative rather than a curative measure for gastric cancer.³

Palliative Operations.—1. *Gastrostomy.* The chief indications for gastrostomy are as follows:

(a) Diseases of the pharynx and larynx in which swallowing becomes impossible.

(b) Cancer of the œsophagus (some cases).

(c) Stricture of the œsophagus that may result from corrosive poisoning, syphilitic, tuberculous, or possibly peptic, ulceration.

(d) Cancer of the cardiac end of the stomach (some cases).

(e) As an avenue for radium in cancer of the stomach or œsophagus (some cases).

The object of all gastrostomy operations is the same, namely, to establish a fistulous communication between the stomach and the surface of the abdominal wall so that the patient may be fed. The operations may be divided into those in which the tract between the stomach and the skin is mucons-lined (Depage-Janeway, Spivack, etc.), and those in which the tract is serous-lined (Stamm, Witzel, etc.).

The former (mucous-lined) type of gastrostomy is performed when a permanent fistula is required, as for an impassible stricture of the œsophagus; the latter (serous-lined) type is undertaken when it appears that the patient has but a short time to live, for instance, for cancer of the cardiac end of the stomach, or as a palliative measure in those conditions in which the disease is capable of being corrected, e.g., chronic peptic ulcer of the lower end of the œsophagus.

STAMM'S OPERATION. This operation is often wrongly credited to Senn, but there is no doubt that it was first described and practised by Stamm who gave an account of this method in the *Medical News* in 1891. This gastrostomy is the simplest and most satisfactory type for cancer of the cardia, and is recommended in preference to the other methods about to be described. The operation can be performed quite satisfactorily under local anæsthesia. Inhalation anæsthetics should, as a rule, be avoided owing to the likelihood of subsequent chest complications; in fact, pneumonia is one of the commonest causes of death following the operation when undertaken under general anæsthesia.

³ Pack, Scharnagel, Quimby and Loizeaux, *Arch. Surg.*, 31:851, 1935.

The incision, which is made over the upper and outer third of the left rectus muscle, commencing precisely on the costal margin and proceeding vertically downward, should be as small as possible, since, owing to the patient's poor general condition, suppuration in the wound is of very frequent occurrence. It also affords the easiest and most direct access to the contracted stomach found in these cases. The cut edges of the peritoneum and posterior sheath of the rectus are picked up with hæmostats and drawn widely apart. As the stomach is small and tubular and lies tucked away under the liver, the first structure which comes into view is usually the great omentum or the transverse colon. By gently pulling the colon downward, the upper portion of the stomach will be seen and can be delivered through the wound. The portion selected for the gastrostomy should be in the body of the stomach, on the anterior wall, as high up as possible and as far removed as may be from the pylorus. The wound is carefully packed off with gauze swabs and mackintosh or cellophane squares soaked in warm saline solution to prevent any contamination of the wound or peritoneal cavity during the further stages of the operation. A point midway between the greater and lesser curvature on the anterior wall of the stomach is selected for the insertion of the tube, and the site is marked off by two pairs of Allis forceps which seize the stomach, draw it into a cone, and lift it forcibly upward. A small opening, sufficiently large to admit a No. 12 or No. 14 Jaques catheter or a length of rubber tubing of about the same diameter, is made between the Allis forceps in the anterior wall of the stomach, either with a knife or an electric cautery (fig. 93, B[1]). The rubber tubing is inserted into the stomach cavity for 2 inches or so, and is attached to the margin of the wound by a catgut stitch which picks up all the coats of the stomach and a small portion of the tube. A seromuscular purse-string suture is introduced $\frac{1}{2}$ -inch away from the tube, and as it is tightened the tube is pushed into the cavity of the stomach, the suture being tied firmly enough to grip without compressing the tube. A second and then a third purse-string suture is then similarly applied, and the margins around the tube are further invaginated, with the result that a cone-shaped portion of the stomach projects into the cavity of the organ, evenly embracing the tube (fig. 93, B [2, 3, 4 and 5]).

The operation is completed by anchoring the stomach above and

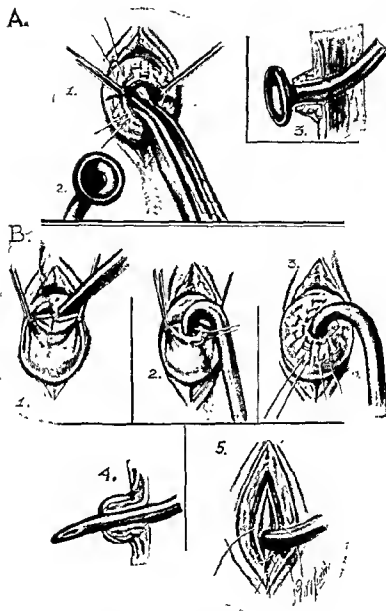


FIG. 93.—STAMM'S GASTRECTOMY.

below the tube to the parietal peritoneum, after which the abdominal incision is closed in the usual manner, the gastrostomy tube being made to project through the lower end of the incision. The tube is plugged with a spigot and fastened to the skin by an encircling stitch which prevents it from being accidentally withdrawn.

Before the patient leaves the theatre, some warm citrated milk is introduced through the tube in order to test its patency and smooth working and also to supply the patient with nourishment which he sorely needs.

After-Treatment. Fluid nourishment is introduced through the tube every two hours during the day and two or three times during the night. It is better to start with small frequent feedings, and gradually to increase the amount until the patient is receiving sufficient at long intervals. At first only 2 to 3 oz. can be given at a time, but later on the stomach will be found to tolerate as much as 5 to 10 oz. at each feed. The fluids most frequently used in feeding are citrated milk, concentrated glucose solutions, beef tea, egg and milk, orange juice, barley water, etc.

The tube works loose in about a fortnight, and should then be removed, sterilized by boiling, and carefully replaced. Apart from this it should be kept continuously in its original position, as otherwise the fistula tends to contract. If, on the other hand, the aperture becomes unduly stretched, a larger catheter may be inserted to prevent leakage, or the fistula may be permitted to contract by removing the tube for a few hours every day.

Before the patient is discharged from hospital he should be instructed how to remove and re-insert the tube, to clean it and to feed himself through it.

WITZEL'S OPERATION. Witzel (*Zentralbl. f. Chir.*, 18:601, 1891) suggested this operation in 1891. This type of serons-lined gastrotomy is indicated where the stomach is unduly small and tubular and where it is very difficult, or perhaps even impossible, to raise a cone from the anterior wall as in Stamm's method. The abdominal incision, the exposure of the stomach and the method of delivering the stomach are the same as in the operation just described. A No. 12 or No. 14 rubber catheter or a length of rubber tubing of the same diameter is introduced for 2 to 3 inches into the cavity of the stomach through a small puncture made in the anterior wall midway between the greater and lesser curvatures. The tube is fixed to the margins of the incision by a single catgut stitch or purse-string suture which pierces the tube. The catheter or rubber tube is then laid on the stomach for 2 inches and firmly pressed into its surface so that it lies in a gutter or groove of stomach wall. This groove is then con-

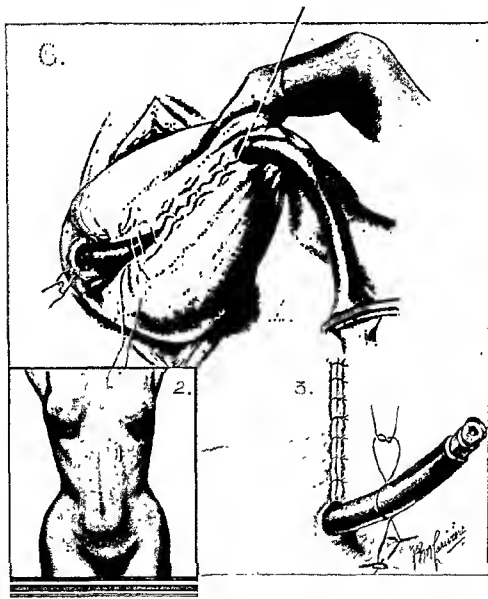


FIG. 94.—WITZEL'S GASTROSTOMY.

verted into a tunnel by the introduction of a series of interrupted Lembert sutures, a continuous Lembert suture or a Cushing right-angled suture. If a Cushing right-angled suture is used, as illustrated in figure 94, it may be wise to strengthen the suture line with a few interrupted sutures of fine silk. The outer opening of the stomach is united to the parietal peritoneum with sutures and the free portion

of the tube is brought out through the lower end of the abdominal incision. The tube is then anchored to the skin to prevent it from being inadvertently withdrawn.

MARWEDEL'S OPERATION. This is a modification of Witzel's method. An incision 2 inches long is made through the seromuscular coat in the anterior wall of the stomach, about midway between the curvatures, down to but not through the mucous membrane. At the lower (pyloric) end of this incision the mucous membrane is perforated and a catheter is introduced into the cavity of the stomach for 2 inches. The catheter, being fixed to the margin of this opening by a catgut stitch, is then made to lie in a tunnel by suturing the edges of the seromuscular incision with a series of interrupted Lembert sutures or a Cushing right-angled suture.

This method has no advantages over Witzel's more simple operation, and, so far as I know, is very rarely performed.

KADER'S OPERATION. The stomach is delivered through the abdominal incision and a catheter or rubber tube is inserted into the stomach, as in Stamm's gastrostomy. Two vertical and parallel seromuscular folds of the anterior wall of the stomach are then drawn together, above and below the tube, by the introduction of a few Lembert sutures. The suture line is further invaginated by the introduction of another series of sutures which pick up the stomach wall on either side of the original line of sutures. The gastrostomy tube is thus buried by a two-fold pleat of stomach wall, and a cube instead of a cone, as in Stamm's operation, is made to project into the cavity of the stomach.

DEPAGE-JANEWAY OPERATION. This operation was first described by Depage in 1901 (*J. de chir. Belge*, 1:715, 1901), was modified by Janeway in 1913 (*Munchen. med. Wchnschr.*, 60:1705, 1913) and is indicated when a permanent mucous-lined gastro-cutaneous fistula is required for feeding purposes. In order to eliminate the possibility of leakage, Spivack (*Bruns. Beitr. z. klin. Chir.*, 147:308, 1929) described an ingenious method, the characteristic feature of which is the formation of a valve at the base of the tube. This valve allows the fluid nourishment to be introduced into the stomach and hermetically closes the stomach whenever the intra-gastric pressure is raised, thus preventing an escape of gastric contents through the tube. This valvular arrangement therefore renders the stomach watertight.

A comprehensive account of Spivack's operation, which is illustrated in considerable detail, will be found in his book, *The Surgical Technique of Abdominal Operations*, and also in Thorek's work, *Modern Surgical Technic* (ed. 3, 1280, 1938). I have, however, been so satisfied with the Depage-Janeway operation, and in my hands the leakage has been so minimal, that I prefer this simpler method to the somewhat complicated procedure of Spivack.

The Depage-Janeway operation is performed as follows: A left transrectus or muscle-split incision, commencing at the costal margin and proceeding downward for 2 inches, is the incision of choice. A large cone of the anterior wall of the stomach, high up and as near to the fundus as possible, is drawn through the wound, which is carefully protected and packed off with waterproof squares and gauze swabs. A large flap of the anterior wall of the stomach, 2 inches by 1 inch, with its long axis stretching from the greater to the lesser curvature and with its base on the greater curvature, is demarcated by picking up the surface of the stomach with four pairs of Allis forceps. Two pairs of these forceps mark the free upper end of the flap and should be placed about 1 inch apart, whereas the forceps which mark the base of the flap are about $1\frac{1}{4}$ inches apart (fig. 95 [2]).

An incision about 1 inch long is then made parallel with the lesser curvature, just above the two upper pairs of Allis forceps and extending down to the mucous coat. All bleeding points are picked up and tied before the stomach is opened with scissors at this site, and a suction tube is introduced to aspirate the gastric contents. The rectangular flap on the anterior wall of the stomach is then cut through with scissors. The Allis forceps on the lesser curvature grasp the whole thickness of the free end of the flap which is turned back, its base acting as a hinge (fig. 95 [3]).

A No. 12 or No. 14 Jaques catheter or a length of rubber tubing of the same diameter is introduced into the stomach for 2 to 3 inches and made to lie in the centre of the rectangular flap (fig. 95 [3]). Firm downward traction is made on the upper end of the wound in the stomach to facilitate the suturing of the mucous membrane.

Starting at the lesser curvature, the edges of the mucous membrane are approximated with a continuous lockstitch, the needle picking up only the mucous membrane and continuing along the flap so that it

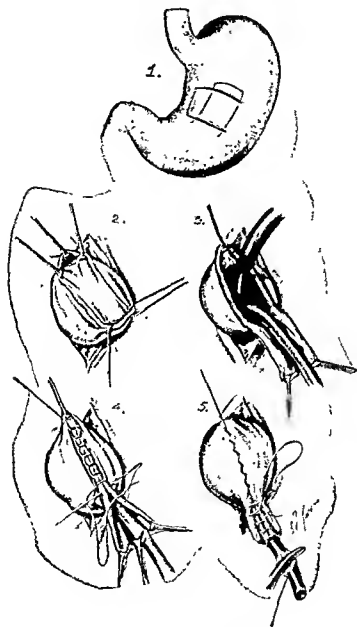


FIG. 95.—DEBAKEY-JANIWAY GASTROSTOMY.

neatly and thoroughly buries the tube. When it reaches the extremity of the flap, the suture is tied gently, and one end is kept long and clamped to the tube by a hæmostat. A suture of No. 0 twenty-day chromic catgut, which is passed as a Cushing right-angled suture, brings together the serous and muscular coats (fig. 95 [5]). When this

suture reaches the end of the flap it is carefully knotted and again clamped to the end of the tube with the same haemostat. At the point where the tube emerges from the gastric flap, it is fixed by a single catgut stitch which pierces all the coats of the flap and a portion of the tube. The gastric flap and tube are then made to project through

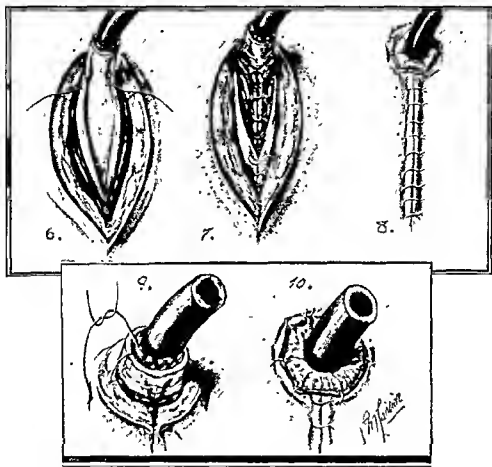


FIG. 96.—DEPAGE-JANEWAY GASTROSTOMY, SHOWING THE METHOD OF ANCHORING THE GASTRIC POUCH TO THE MARGINS OF THE SKIN.

the upper portion of the incision. The tube of gastric wall is anchored to the upper portion of the wound by a stitch which picks up the margins of the peritoneum and a small portion of the seromuscular coat of the flap. The edges of the peritoneum are then sutured, after which the margins of the divided rectus muscle and rectus sheath are approximated by interrupted sutures and the wound is closed

up to the point where the gastric tube emerges at the top end of the wound. Sufficient traction is made on the mucous membrane of the gastric tube to facilitate its being sutured to the adjacent skin margins (fig. 96).

Quick and Martin (*Surg., Gynec. & Obst.*, 46:426, 1928) reported a series of 172 cases in which this operation was performed with a mortality of 18 per cent. Since 1928, however, by modifying their technique to guard against wound infection, Martin and Watson have been able to report 52 cases with a mortality of 3, *i.e.*, 5.8 per cent.

After-Treatment. Three ounces of peptonised milk are given 3-hourly, this being increased until the patient is receiving 8-10 oz. every 4 hours. During the first three or four post-operative days rectal or intravenous salines should be given to combat dehydration which is such a marked feature in these cases. The tube is removed on the eighth day and inserted again only when it is required for feeding purposes. The gastric fistula proves most satisfactory, and leakage is minimal.

Pavlov employed a similar operation for his experiments on the gastric secretions of dogs.

2. *Jejunostomy.* In cases of cancer of the stomach, jejunostomy may occasionally be indicated:

(a) As an alternative procedure to gastrostomy.

(b) Where the invasion of the stomach wall with growth is so extensive that it renders the performance of a gastro-jejunostomy or a gastrostomy impossible.

(c) In cases of irremovable malignant hour-glass stomach.

(d) Where there is obstruction of the duodeno-jejunal flexure or proximal jejunum, due either to spread of the growth from the stomach or to malignant glands at the root of the mesentery.

The best type of jejunostomy is Witzel's, and the more complicated ones of Mayo-Robson, Coffey, Travel, etc., are not recommended.

3. *Gastro-Jejunostomy.* I am very doubtful whether gastro-jejunostomy will, in the future, have any place in the treatment of cancer of the stomach. Most surgeons have at one time or another performed this operation for irremovable cancer of the pyloric segment of the stomach, with the objects of relieving obstruction, of

making the patient more comfortable and of prolonging life. Although gastro-jejunostomy is a simple operation, it is associated with a high operative mortality when carried out for cases of gastric carcinoma, namely 15 to 20 per cent, and the relief it affords is transient at best. In my own cases I have formed the impression that instead of prolonging life it has been actually instrumental in shortening it. Few patients survive the short-circuiting operation for more than six months, and the majority are dead in four months. In contrast to this, the average expectancy of life following simple exploration is about 8 months.

If the surgeon elects to perform gastro-jejunostomy for a case of irremovable cancer of the pylorus, he will in most instances be obliged to carry out the anterior operation as the posterior route is often blocked by spread of the growth and by the marked fixation of the stomach. The operation will therefore have to be an anterior gastro-jejunostomy with an entero-anastomosis between the proximal and distal limbs of the jejunum. A loop of proximal jejunum, 14 to 18 inches in length, is drawn upward in front of the transverse colon and the part of the loop selected for the anastomosis is applied to the lowest point of the greater curvature. It is immaterial whether the portion of jejunum selected for the anastomosis to the stomach is placed from right to left (anti-peristaltic) or from left to right (isoperistaltic). When the anastomosis is made at the most dependent part of the stomach the emptying is satisfactory, but there is a tendency to make the anastomosis high up in the stomach with the result that the stoma functions poorly.

The anastomosis of the jejunum to the stomach is performed in the usual manner, but it is important to ensure wide approximation of jejunum to stomach with a seromuscular suture to prevent any kinking of the afferent and efferent loops.

The operation is completed by making an entero-anastomosis between the proximal and distal loops of the jejunum, about 2 inches or so above the level of the duodeno-jejunal flexure.

4. *Exclusion of the Growth.* This operation was devised by Devine (*Surg., Gynec. & Obst.*, 40:1, 1925) and is a modification of von Eiselsberg's method of pyloric occlusion.

The operation is simplicity itself and consists of transecting the stomach high up, and after securely closing and invaginating the

distal or pyloric segment, the cut proximal end of the stomach is anastomosed to the proximal loop of jejunum, as in the Polya operation. It is preferable to make the anastomosis ante-colic rather than retro-colic, and an entero-anastomosis between the proximal and distal jejunal loops is not an essential feature of the operation.

This operation ensures that the patient will not die of obstruction, as the gastro-enteric stoma is very large and is widely removed from the primary growth which is excluded. Where, however, a gastro-jejunosomy is performed, the stoma is likely to become occluded by growth, which spreads into the body of the stomach from the pyloric region, or to become compressed by metastatic nodes in the mesocolon or great omentum.

The immediate post-operative results, as I have shown, (*Ann. Surg.*, 101:161, 1936) are eminently satisfactory. It is at once possible to administer fluid nourishment by mouth in unstinted quantities, appetite is restored, cachexia disappears, and the patient's general health is greatly improved. There is little doubt that this operation will prolong life for a longer period than any other form of palliative operation, with the possible exception of palliative resection. The operative mortality, too, is no higher, in fact it is often lower than that which obtains following the simple short-circuiting operations. The secondary growths in the liver, which produce less pain than obstruction, are usually the cause of death in these cases. Balfour has frequently stressed that this operation has a wider application than has hitherto been accorded to it, and he has often been surprised at the length of comfortable life which followed the operation when it was clearly indicated.

5. *Palliative Excision of the Growth.* Wherever possible, even in cases in which there are secondary growths in the liver, if the malignant mass in the stomach can be resected together with a healthy margin of gastric wall, this should be undertaken, as by performing partial gastrectomy on these incurable cases the patient is rid of a foul, necrotic, sloughing mass, toxæmia is markedly diminished, obstruction is prevented, and a period of improved health and comparative freedom from pain is assured for at least several months longer than that afforded by gastro-jejunosomy.

Radical Operations. Before discussing the various types of radical operations for cancer of the stomach—and these are of three varieties,

namely, the Billroth I types of repair, the Polya methods with their numerous modifications, and total gastrectomy—it is advisable to give a brief outline of the pre-operative management of cases of cancer of the stomach which are deemed operable.

Outline of Pre-Operative Treatment. (a) **SPECIAL DIET.** Until the evening before the operation, in the average case the patient is kept on a light nutritious, assimilable, non-residue diet which is rich in sugars, fats and vitamins. He is encouraged to take large quantities of cream, malt and cod-liver oil, and sweetened fresh lemon juice. When there is any degree of gastric stasis, however, it is wiser to withhold solid food altogether and to keep him on fluid nourishment. The more water he can drink the better; if he can take 5 pints of water, barley water, diluted fruit juices, etc., in twenty-four hours, he is doing well, but if he drinks 10 pints he is doing even better.

(b) **INTRAVENOUS INFUSIONS.** Salines and glucose are introduced into the circulation to combat the dehydration which is so often present, and to stimulate hepatic and renal function. Blood transfusion by the continuous drip method is a routine procedure for all cases of cancer of the stomach which are awaiting operation. The drip is commenced a few hours before the operation and continues throughout the operation and for the first twenty-four hours or more after the operation. The patient receives at least 2 pints of blood, which is given very slowly and in regulated amounts. I am convinced that this additional measure has done much to reduce the mortality in cases of sub-total gastrectomy for cancer of the stomach.

(c) **GASTRIC LAVAGE AND MEDICINES.** The contents of the stomach are aspirated and lavage is performed with hypertonic saline or with 0.25 per cent hydrochloric acid once or twice a day and always one hour before operation is undertaken. For a few days before the operation, adopting Horsley's advice, I make it a practice to prescribe an acid tonic mixture containing sweetened diluted hydrochloric acid. The hydrochloric acid does much to diminish the sepsis which is so often present with growths in the stomach, particularly when such growths are necrotic. Pain is assuaged by giving 10 to 20 drops of nepenthe in milk three times a day, sleep being assured with moderate doses of medinal, luminal or adalin.

(d) **ARTIFICIAL SUNLIGHT BATHS.** The results of giving these often are markedly beneficial.

Exploratory Laparotomy. At operation it is important not only to explore the stomach, the regional lymph nodes and the liver, but to inspect and palpate all the possible sites in which secondary deposits of growth are likely to occur. The exploration should be methodical and should commence by an examination of the stomach itself. The size, the shape and the position of the stomach should all be especially noted. The large prolapsed stomach usually lends itself easily to gastrectomy, whereas the small contracted tubular stomach presents considerable difficulty in resection in that it lies high up and is tucked away under the liver and diaphragm. The extent and the position of the growth should next be ascertained. Growths situated in the region of the cardia are often impossible to resect as they frequently involve the lower portion of the œsophagus and the diaphragm. If in such cases the intra-abdominal portion of the œsophagus is long and unduly mobile and the growth appears to be comparatively limited, it may be feasible to perform total gastrectomy; but, as I have stated, the majority of cancers of the cardia or of the lower end of the œsophagus do not lend themselves to resection, and gastrostomy has frequently to be undertaken to prevent the patient from starving to death. Nevertheless, during recent years an increasing number of successful cases of resection of the cardia and of the lower 2 to 3 inches of the œsophagus, followed by anastomosis of the end of the resected œsophagus with the fundus of the stomach, making normal swallowing possible, have been accomplished. Marshall (*Lahey Clinic Bull.* 1:13, 1938) has given a very clear account of the various steps of the operation, together with the report of a successful case.

Malignant growths situated in the fundus or on the greater curvature are usually of the polypoid type and are slow-growing. In some cases it is possible to remove the growth locally, together with a wide margin of healthy stomach and adjacent omentum, while in others it may be preferable to perform sub-total gastrectomy. The outlook with growths springing from the body of the stomach is favourable in the early stages, as they do not metastasise so readily as growths in the pyloric region. It is said that fully 60 per cent of gastric carcinomata originate in the pyloric segment and that growths in this position, as they produce symptoms early in the course of the disease and are operated upon without delay, give the most favourable

prognosis. This, however, is not usually the case, as infiltration of the underlying head of the pancreas and fixation of the growth to this organ, together with widespread metastatic implants in the regional lymph nodes, soon ensue, thus reducing the chances of permanent cure.

With the chronic scirrhus growths situated in the pyloric canal, the prognosis is good as involvement of the regional lymph glands is of slow progress. Nevertheless, at operation the pylorus should be tested for mobility and the supra- and infra-pyloric groups of glands carefully palpated to determine their degree of involvement. In actual practice, malignant growths situated in the middle third of the lesser curvature prove more easy to resect than those in the pyloric region, and the affected glands can be removed without much difficulty.

An important step in the operation is the palpation of the whole of the lesser curvature to ascertain to what extent it is involved, as if it is apparent that the growth has spread upward and invaded the region of the œsophageal orifice, as a rule no radical operation can possibly be attempted. The surgeon should, however, bear in mind that undue thickening of the lesser curvature may be due rather to inflammatory œdema, to fibrosis, or even to muscular hypertrophy, than to growth.

Total gastrectomy is advised for the localised and generalised varieties of leather-bottle stomach, in fact this is the main indication for total ablation of the stomach, which carries with it a mortality of 50 per cent. Up to date no patients have survived this heroic procedure for more than five years. It must be emphasised that fixation of the stomach may be due to inflammatory adhesions and does not necessarily preclude resection. Adhesion of the stomach to the anterior edge of the liver may similarly be due to inflammatory adhesions, and in some cases, even when it is the result of direct spread of growth, the margins of the liver may be excised in order to facilitate the mobilisation of the stomach prior to gastrectomy.

In certain cases where the transverse colon has become involved with growth, either directly or through the medium of the great omentum, it may be possible to resect a portion of the colon together with the stomach and great omentum. Enlargement of the lymphatic glands does not necessarily entail involvement by cancer, and Balfour

states that a patient may be cured after partial gastrectomy even when all the involved lymph nodes are not removed. The lymph glands must all be examined systematically, particularly the group which surrounds the pyloric portion of the stomach and the first inch or so of the duodenum. The glands which lie along the lesser curvature, the compact celiac axis group, those tucked away in the portal fissure, and those at the root of the mesentery should also be carefully palpated and inspected in every instance.

Having completed the examination of the lymphatic area, the omentum and the mesocolon should next be scrutinised for areas of involvement or seedlings of growth. A purely local involvement of the omenta does not exclude the possibility of resection, but widespread growth or extensive implants in the omenta spell inoperability.

The liver should be inspected and palpated for secondary growths, and a hand should be passed over the upper surface to detect any nodular growth or irregularities. The peritoneum should be examined for minute seedlings of growth—carcinomatosis—and a hand should be passed into the recto-vesical pouch to discover whether there are any implants in the pelvic shelf. In the female, both ovaries are examined as a routine in order to determine whether tumour masses have formed here through cancer cells having alighted by gravitation upon their surfaces.

The Choice of Operation. As I have previously stated, the chief indication for total gastrectomy is leather-bottle stomach. The details connected with this operation are described on page 477.

While most surgeons would agree that radical sub-total gastrectomy by one of the Polya methods is the ideal procedure for cases of cancer of the stomach, it must, nevertheless, be conceded that in certain instances the Billroth I types of repair are clearly indicated. There are numerous criticisms against the Billroth I operation. It is often claimed, for instance, that the surgeon is more concerned with the approximation of the gastric stump to the cut end of the duodenum than with wide excision of the growth, and that he will consequently sacrifice too little stomach in order to achieve an easy junction. Again, that, if there is a recurrence of the growth, the narrow gastro-duodenal stoma will soon become blocked. Nevertheless, in elderly and poor-risk patients, the Billroth I operation has much to offer in that it is associated with a lower operative death-rate

than the Polya operations, and as the operative field is confined solely to the supra-colic compartment there is less shock and less risk of contaminating the peritoneal cavity with gastric or intestinal contents, while walling off of the stomach and of the region of the anastomosis is easily accomplished. Moreover, the time factor may be important. The Billroth I type of operation can certainly be performed in a shorter time than that required for the more complicated and radical types of procedure, and there may be some advantages in restoring the parts after resection to conditions which physiologically approximate more or less to normal. I agree with Cattell and Colcock (*Surg. Clin. N. Am.*, 667, June, 1937) who consider that it is most important not to decide upon the type of anastomosis until after the stomach has been resected to the degree demanded by the type and extent of the lesion present. It should by no means be a factor in determining the scope of the resection to be carried out.

There are, of course, many ways of performing the Billroth I operation when this operation is indicated for cancer of the stomach. The technical details of the various types of Billroth I operations when employed for cancer of the stomach are the same as those already described on page 235, with the exception that pains must be taken to remove all the involved lymphatic glands, and that a wider margin of the stomach must be resected. Success with this operation depends upon thorough mobilisation of the duodenum and of the stomach itself. I have often found that by mobilising the lower border of the gastro-splenic omentum and even the spleen itself, the lower cut end of the stomach can easily be brought across to the divided end of the duodenum without tension.

After the stomach and duodenum have been mobilised and the omenta divided, one of the simplest methods is to cut across the duodenum between two clamps, about $1\frac{1}{2}$ inches from the pyloric sphincter, to draw the stomach well out of the wound, to apply a Friedrich-Petz clamp high up on the body of the stomach so as to force the clips home, and to transect the stomach with an electric cautery between the two rows of clips. The surgeon should then test the degree of mobility which he has achieved with the remaining gastric pouch and ascertain whether this can be drawn downward to the duodenum without any degree of tension. If this can be accom-

plished and if in the particular case the Billroth I method would appear to be advisable, he can then proceed with this operation which is very speedily carried out by inverting the upper half of the closed end of the stomach, after which the crushed groove with its clips in the lower half of the stomach is trimmed away, and this portion is anastomosed to the cut end of the duodenum by one of the methods already described.

When the operation is completed, particular care should be taken to invaginate thoroughly the upper and lower margins of the anastomosis and to protect this area with adjacent remnants of omenta.

Sub-Total Gastrectomy for Cancer of the Stomach. The essentials of all sub-total gastrectomy operations include:

(a) **PERFECT TECHNIQUE.** Before the operation is commenced the operative field should always be packed off thoroughly by inserting a number of waterproof squares around the margins of the wound and deep into the abdominal cavity to prevent the intrusion of unruly intestines. On top of this are placed large moist gauze packs so that the area of operation is completely excluded from the rest of the abdominal cavity. The moist gauze swabs may be changed from time to time, but the waterproof squares are left in position until the completion of the operation. Hæmostasis must be absolute, the minutest blood vessels being carefully tied and any large vessel doubly ligated, preferably with silk. If there is a small area of oozing, this must be attended to before proceeding with the further steps of the operation. The suture lines must likewise be carefully approximated and sufficiently reinforced with interrupted mattress sutures of silk. It is advisable to use silk sutures rather than catgut in making the anastomosis owing to the poor healing power of the tissues.

Finally, the mechanics of these operations should always be sound. The thing to avoid particularly is tension at the line of anastomosis or any drag or pull at the duodeno-jejunal flexure or on the proximal limb of the jejunum. The anastomosis when completed should be supple, and the proximal and distal limbs of the jejunum should possess a fair degree of range of movement.

(b) **EXCISION OF THE GROWTH WITH A WIDE MARGIN OF HEALTHY TISSUE ABOVE AND BELOW THE DISEASED AREA** (figs. 97 and 98). This would also include: (i) the removal of at least two-thirds of the first portion of the duodenum; (ii) the removal of the whole or nine-

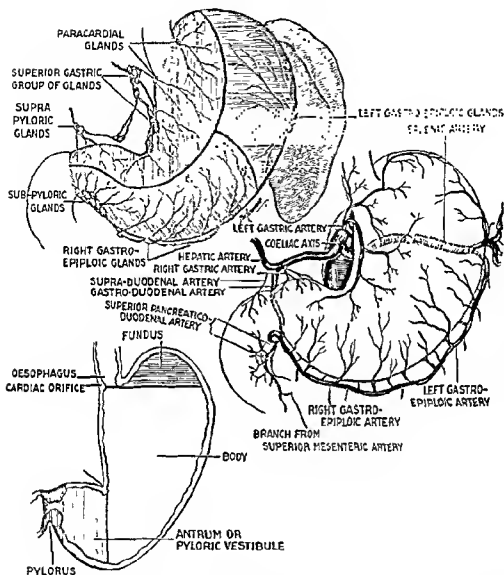


FIG. 97.—ANATOMICAL SUB-DIVISIONS OF THE STOMACH, BLOOD SUPPLY AND LYMPHATIC DRAINAGE.

tenths of the lesser curvature of the stomach; (iii) the removal of at least three-quarters of the greater curvature of the stomach; (iv) the removal of all the regional lymph glands, such as the supra-pyloric, the retro-pyloric and the infra-pyloric, the glands along the lesser curvature—lower coronary and upper coronary—, the paracardial glands, and those along the greater curvature—the gastro-epiploic;

(v) the removal of the great omentum, which is detached from the colon, and the major portion of the gastrohepatic omentum.

The essential steps of the operation are as follows: The great omentum is detached from the transverse colon, after the manner described by Hey Groves (*Proc. Roy. Soc. Med.*, 3:117, 1910). Sometimes a fringe of omentum may be left at the extreme margins, *i.e.*, at the duodenal end and in the region of the splenic flexure (fig. 98). The lower third or so of the gastro-splenic omentum should be freed to facilitate the mobilisation of the stomach.

The next step consists in freeing the duodenum and mobilising the first portion of it. The pyloric glands should be gently stripped and dissected toward the stomach to free the under-surface of the pylorus and the first portion of the duodenum, where the gastro-duodenal artery will be seen lying in a deep groove in the head of the pancreas. This artery is isolated close to the upper border of the pylorus, tied in two places and divided. By doing this the freeing of the duodenum, particularly at its posterior and medial aspect, becomes a comparatively bloodless undertaking. By retracting the first portion of the duodenum firmly downward, the sheaf of pyloric vessels comes into view, and these are underrun with an aneurysm needle and tied with stout silk. When this artery is divided, the pylorus is freed and the first part of the duodenum can be mobilised more thoroughly. The right gastro-epiploic and the pancreatico-duodenal arteries are then ligatured and divided, and the first portion of the duodenum is isolated and divided between two crushing clamps. The duodenal stump is next over-sewn, closed, and inverted with a purse-string suture of silk. This may be reinforced with a few interrupted mattress sutures of fine silk. The fan-shaped gastrohepatic omentum is snipped with scissors as high up as possible and stripped downward toward the lesser curvature. In doing this the glands which lie in the region of the cœliac axis are swept downward with their fatty envelope and thus remain attached to the lesser curvature.

The left gastric (coronary) artery can now be clearly seen, springing from the cœliac axis. This is underrun with an aneurysm needle and tied off in two places in continuity, after which the artery is divided between the ligatures. The branch which goes upward toward the œsophagus is next isolated, ligatured and divided close to the right



FIG. 98.—SUB-TOTAL GASTRECTOMY.

The amount of duodenum, stomach, great omentum, gastrohepatic omentum, glands, etc., which are removed in the operation of sub-total gastrectomy.

border of the œsophagus or at least just proximal to the cardiac orifice. A little dissection is needed here to free the first inch or so of the lesser curvature of blood vessels, fat and lymphatic glands. The raw surface on the lesser curvature is then re-peritonised with a few interrupted silk sutures. The left gastro-epiploic artery is next securely tied and divided near the lower pole of the spleen.

It will be seen that the stomach is now very mobile and can be

drawn fully through the wound. It is attached merely by the œsophagus above and by its connections with the spleen below. I consider that a large area of stomach can be resected by avoiding the use of clamps altogether, although where speed is essential the Friedrich-Petz clamp may be used to facilitate the excision and the anastomosis of the cut end of the stomach with the jejunum. In the average case a fairly long loop of proximal jejunum, some 8 to 10 inches in length, is brought up anterior to the transverse colon and applied to the posterior surface of the stomach as high up as possible. The proximal portion of the jejunum selected for the anastomosis is applied to the lesser curvature, and the distal portion to the greater curvature (fig. 99).

The anastomosis is commenced by suturing the jejunum to the stomach with a series of interrupted silk sutures, after which a continuous posterior seromuscular suture of the right-angled Cushing type is inserted. The seromuscular coat of the stomach is then divided down to the mucosa posteriorly about half an inch away from and parallel to the posterior line of sutures.

The stomach is next turned over to the right to expose its anterior surface and an incision is made through the serous and muscular coats down to the gastric mucosa in the line selected for the transection. The numerous blood vessels which course over the exposed surface of the mucosa are underrun and tied individually to ensure complete hæmostasis. A small puncture is then made through the mucous membrane of the stomach and a suction tube inserted to withdraw all the gastric contents. The mucous membrane of the stomach posteriorly is divided for the whole length of the seromuscular incision in the posterior wall of the stomach and a corresponding incision is made through the adjacent jejunal wall. The adjacent margins of the cut edge of the stomach and jejunum are next approximated by a continuous mattress suture which commences at the greater curvature and proceeds toward the lesser curvature. On reaching this point the stomach is cut adrift and this suture is continued anteriorly as a through-and-through all-coats hæmostatic suture which draws together the anterior margins of the stomach and jejunum. When this suture reaches the greater curvature it is tied to the end which has been left long. The posterior Cushing suture is now picked up again and continued anteriorly, approximating the seromuscular



FIG. 99.—SUB-TOTAL GASTRECTOMY FOR CARCINOMA OF THE STOMACH.

The stomach is being transected between two rows of Petz clips. The proximal loop of jejunum is drawn upward to the lesser curvature of the stomach in front of the transverse colon—*anterior Polya type of anastomosis*.

coats of the stomach and jejunum and invaginating the anterior line of sutures.

The operation is completed by introducing a series of closely ap-

plied interrupted mattress sutures of fine silk which invaginate the anterior suture line and further reinforce it. At the lesser curvature two or three additional sutures are inserted, as this often constitutes a weak spot.

At the completion of the anastomosis an entero-anastomosis between the proximal and distal jejunal loops is not performed, as in practice this has been found unnecessary. If the surgeon considers that it is going to be difficult to utilise the upper cut end of the stomach for the anastomosis, it is wiser to close the upper half and to use the lower half for the anastomosis.

When the Friedrich-Petz clamp is employed, the stomach should be drawn as firmly as possible between the blades of the clamp in order that the greatest possible amount of stomach may be resected. After the clips have been introduced it will be seen that they run along an oblique line stretching from a point one inch or so from the œsophageal opening, downward toward the lower pole of the spleen. After the portion of jejunum selected for the anastomosis has been sutured to the posterior aspect of the stomach by a series of interrupted silk sutures, the stomach is divided between the two rows of Petz clips (fig. 99). The upper half of the cut end of the stomach embraced by the Petz clips is inverted by a series of interrupted sutures, after which the lower half of the cut end of the stomach is prepared for the anastomosis. The Petz clips in this portion are removed with scissors, and the anastomosis is then carried out in the usual manner (fig. 100).

Total Gastrectomy. In this operation the entire stomach is excised and the cut end of the œsophagus is anastomosed to the cut end of the duodenum (œsophago-duodenostomy) or to a loop of proximal jejunum (œsophago-jejunostomy). When the resected stomach is examined it will be seen to include at its pyloric end one inch or so of the first part of the duodenum, and at its cardiac orifice end a small fringe of the intra-abdominal portion of the œsophagus.

Total gastrectomy must be distinguished from sub-total gastrectomy in which a portion of the body of the stomach and fundus is left behind. The distinction is important, as there are a number of cases recorded in the literature as being total gastrectomies which, from the details, prove in fact to have been merely sub-total excisions of the stomach.

Total gastrectomy was first performed by Connor in 1884 (*Medical News*, 45:578, 1884). His patient died from shock shortly after the operation. Schlatter (*Chir.*, 191:757, 1897) had the distinction of being the first surgeon to resect the entire stomach successfully. His

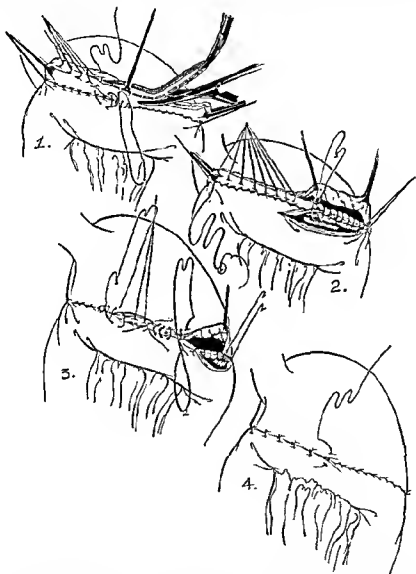


FIG. 100.—SUB-TOTAL GASTRECTOMY FOR CARCINOMA OF THE STOMACH.

The anastomosis between the small gastric pouch and the proximal jejunum is being conducted without the aid of clamps. Note that the upper half of the cut end of the stomach is closed and the lower end, i.e., toward the greater curvature, is being anastomosed to the jejunum.

patient was a woman aged 56 who lived for fourteen months following the operation (which was an œsophago-jejunosomy), and died from secondary deposits in the liver. Paterson (*Hunterian Lect.*, 1906) collected 27 cases of total gastrectomy for cancer of the stomach and of these 10 died as a result of the operation and 17 recovered. Moynihan (*Lancet*, 2:1748, 1907) gave his well-known classical account of the technical points of the operation and reported in detail a case of total gastrectomy for leather-bottle stomach. The patient upon whom he had operated was a man aged 43, who continued to live in good health until a few months before his death 3 years after the operation. This man died of pernicious anæmia, not of secondary deposits. The many readers of *Abdominal Operations* will remember Moynihan's vivid description of this case and his lucid account of the various steps of his successful operation.

Finney and Rienhoff (*Arch. Surg.*, 18:140, 1929) carefully tabulated most of the cases which had been recorded up to 1929. They were able to quote 62 cases from the literature and they added 5 of their own. In these 67 cases there was a 53.8 per cent mortality, but there was a higher recovery with œsophago-jejunosomy than with œsophago-duodenostomy.

Roeder (*Ann. Surg.*, 98:221, 1933), in a comprehensive article, reported 88 cases including 3 of his own, with a mortality of 44, i.e., 50 per cent. During the last six years many valuable papers have appeared on this subject, and we have now access to the reports of many recent cases. It is difficult to estimate the number of total gastrectomies which have been performed in Great Britain, but Joll has reported 12 cases, Walton 6, Gordon-Taylor 6, and Maingot 6. Waltman Walters analysed 20 cases which were operated upon at the Mayo Clinic between 1917-1934. Allen described 16 cases subjected to operation at the Massachusetts General Hospital, and Lahey (*Surg., Gynec. & Obst.*, 67:213, 1938), in an article replete with the most useful information, has given us an account of his experiences with eight patients, five of whom successfully recovered from the operation and lived for varying periods of time after returning to their homes.

Waltman Walters' paper on the "Physiologic and Chemical Studies following Successful Total Gastrectomy for Cancer" (*J. Am. M. Ass.*, 95:102, 1930) is an illuminating dissertation and has a distinct bearing upon the post-operative management of these cases.

Roeder very rightly considers that this heroic operation is being performed more frequently today because the number of operators is increasing, methods of anæsthesia are safer, marked advances are being made in operative technique, there is a wiser choice of the patients to be operated upon, and pre-operative treatment is more intensive.

INDICATIONS FOR TOTAL GASTRECTOMY. 1. The growth must be confined entirely to the stomach and must not extend beyond the adjacent lymph nodes, which must themselves be readily removable.

2. The stomach must be freely mobile and its excision must present no great technical difficulties. Moreover, the intra-abdominal operation of the œsophagus must be uninvaded by growth and be capable of being mobilised to permit of an easy approximation of the cut end of the œsophagus to a loop of proximal jejunum.

3. The general condition of the patient must be such following a well-planned pre-operative regime that a radical and extensive surgical procedure of high risk may in skilful hands be carried out with reasonable expectation of recovery.

In other words, the operation is especially indicated in cases of leather-bottle stomach in which there are no evidences of metastases in the liver or peritoneum, in cases of multiple leiomyosarcomata confined to the gastric wall, and where diffuse polyposis is associated with recurrent profuse hæmatemesis. Total gastrectomy is not a justifiable procedure for gastric ulcer or for the more localised types of gastric malignancy.

TECHNIQUE OF TOTAL GASTRECTOMY. The anæsthetic of choice is a high spinal, using percaine which will afford complete anæsthesia lasting for well over two hours, and the best approach to the stomach and œsophagus is a long left paramedian incision which commences over the left lower costal cartilages and extends downward to the umbilicus. It is unnecessary, and in fact harmful, to retract the left costal margin by division of the lower costal cartilages, as has been suggested by Marwedel and more recently by some American surgeons.

Before undertaking the operation, a most scrupulous examination of the stomach, the œsophagus, the regional lymph nodes and the liver should be carried out to determine not only whether there is any extra-gastric involvement but also to test the mobility and pos-

sible case with which the stomach can be resected and to gauge the length of the intra-abdominal portion of the œsophagus. If the stomach is fixed to the pancreas posteriorly, if the œsophagus is very short and appears to be involved in growth, or if there are any visible metastases in the liver or mesocolon, it is not wise to proceed with this operation.

The first step in the operation consists in freeing the stomach from its vascular attachments. Most surgeons remove the great omentum by detaching it from the transverse colon, leaving it attached to the stomach which is about to be excised; others, on the other hand, prefer to tie off the gastro-colic omentum piece by piece all along the greater curvature and to continue the freeing upward toward the œsophagus by ligaturing off the entire filmy gastro-splenic omentum and at the duodenal end by freeing the first portion of the duodenum after tying the right gastro-epiploic artery. The left gastro-epiploic artery should be ligated as it sweeps round behind the posterior wall of the stomach near the lower border of the spleen, and great pains must be taken in freeing the gastro-splenic omentum not to injure the underlying vessels which run to the hilum of the spleen.

After the greater curvature has been freed for its entire extent, the suspensory ligament of the left lobe of the liver should be cut across with scissors, after which this portion of the liver can be turned down upon itself and held out of the way with a retractor in the manner suggested by Grey Turner (*New England J. Med.*, 205:657, 1931). The right gastric (pyloric) artery is next isolated, ligatured and divided, the gastrohepatic omentum is freed, and after ligaturing the left gastric artery close to its origin, the upper third of the lesser curvature and the right margin of the œsophagus are bared.

The next step consists in thoroughly mobilising the first portion of the duodenum and dividing it between clamps fully 1½ inches away from the pyloric outlet. The distal end of the duodenum is then oversewn and closed and further invaginated with a purse-string suture of silk. The stomach is now wrapped in gauze soaked in saline to prevent any contamination of the incision or abdominal cavity with cancer cells during the process of its excision, and is drawn firmly downward to render the peritoneum over the œsophagus taut. The peritoneum in this region, which is reflected from the diaphragm

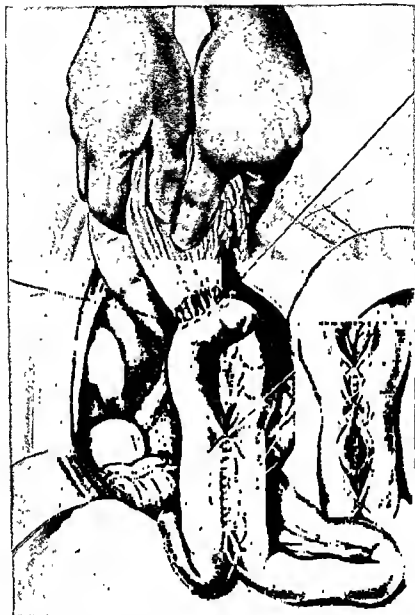


FIG. 101.—TOTAL GASTRECTOMY FOR LEATHER-BOTTLE STOMACH.

The jejunal loop selected for the anastomosis is being sutured to the posterior aspect of the œsophagus by a series of Halsted sutures. An entero-anastomosis between the proximal and distal loops of the jejunum is also being performed.

over the anterior surface of the œsophagus, is then cut in a U-shaped flap, after which this flap is dissected free from the œsophagus by gauze dissection and held out of the way with a pair of Allis forceps.

Firm traction should be made on the stomach, drawing it forcibly upward toward the left shoulder to display the posterior aspect of the œsophagus, which is freed to permit of a further mobilisation.

It should be possible to draw down at least 1 inch or more of the intra-thoracic portion of the œsophagus after this process of freeing has been completed.

A portion of the jejunum some 8 to 10 inches from the duodeno-jejunal flexure is selected for the anastomosis, brought in front of the transverse colon and laid against the under-surface of the œsophagus which is now well displayed by exerting steady traction on the stomach in an upward direction toward the patient's chin (fig. 101).

The jejunum is sutured to the posterior wall of the œsophagus with a series of interrupted mattress sutures of silk, and at the right and left extremities of the suture line two of these sutures are left long to act as tractors (fig. 101). In front of these interrupted sutures a small opening is made into the œsophagus at the extreme left end of its attachment, and a suction tube is introduced into the œsophagus and then into the stomach to remove any contained secretions. A similar small opening is made through all the coats of the jejunum, $\frac{1}{4}$ -inch below the interrupted sutures, and the posterior continuous lockstitch suture is introduced (fig. 102).

These openings in the œsophagus and jejunum are enlarged little by little from left to right, and as they are enlarged their cut edges are sutured together. This sequence of a small incision, a few stitches, slight enlargement of the incision, and a few more stitches, is continued until the whole of the posterior wall of the œsophagus has been divided and sutured to the adjacent margin of the jejunum (fig. 102). Around the anterior wall of the œsophagus the same sequence is continued, the stitch now being changed to a Connell type or to the ordinary through-and-through all-coats hæmostatic suture. The stomach is therefore used as a tractor, drawing down the œsophagus until the last piece is severed, at which juncture the line of anastomosis is completed, whereupon the anterior suture line is further reinforced and invaginated with a series of interrupted mattress sutures of silk. A few anchor sutures fixing the jejunum to the diaphragm on either side of the anastomosis are inserted to prevent the œsophagus from slipping upward into the thoracic cavity.

The small posterior flap of diaphragmatic peritoneum which was

fashioned when the œsophagus was being freed posteriorly is attached to the posterior wall of the jejunum with three or four interrupted sutures, and when this is completed the anterior flap of diaphragmatic peritoneum is attached to the anterior wall of the jejunum below the anastomosis to relieve the suture line from traction.

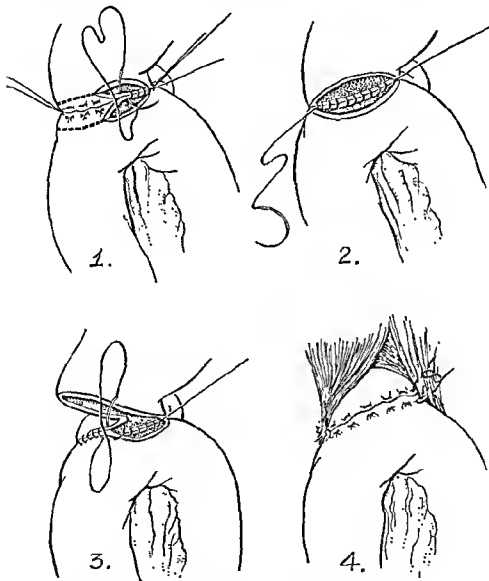


FIG. 102.—TOTAL GASTRECTOMY FOR LEATHER-BOTTLE STOMACH.

Method of anastomosing the selected loop of jejunum to the œsophagus is depicted step by step.

In order to make quite sure that there will be no pull or strain at the line of anastomosis, a portion of the jejunum proximal and distal to the anastomosis is stitched to the diaphragm also. Great importance is attached to relieving as far as possible any strain on the suture line owing to the fact that the œsophagus is very friable and leakage at the suture line is very prone to occur.

The operation is completed by making a small entero-anastomosis between the proximal and distal loops of the jejunum, about 2 inches or so above the duodeno-jejunal flexure (fig. 101). This is done to divert the bile and pancreatic juices away from the anastomosis and at the same time to prevent the dumping of food into the proximal loop of the jejunum.

It has been my practice to pass a small stomach tube through the nose and to guide it through into the posterior loop of the jejunum well beyond the entero-anastomosis, so that the patient may be fed through this tube for the first three or four post-operative days. I think this method has many advantages over that of a jejunostomy which has been recommended by some surgeons. Lahey, however, considers that the entero-anastomosis is unnecessary and also that either an indwelling jejunal tube or a jejunostomy is superfluous.

Anastomosis of the cut end of the œsophagus to the cut end of the duodenum (œsophago-duodenostomy) is not recommended, as, however carefully and thoroughly the duodenum is mobilised, it is impossible to unite it to the cut end of the œsophagus without a certain degree of tension. Again, after the duodenum has been mobilised its posterior wall is devoid of peritoneum, and since it is a friable structure like the œsophagus, the anastomotic line is likely to be less secure than when the œsophagus is united to the jejunum.

All authorities agree that œsophago-duodenostomy has a much higher mortality than œsophago-jejunostomy, and for this reason as well as for those mentioned above it is always preferable to anastomose the œsophagus to a loop of the proximal jejunum, as already described.

SARCOMA

Ewing has estimated that 1 per cent of all gastric tumours are sarcomatous, but Anschutz and Konjetzny place the incidence at 2 per cent. D'Aunoy and Zoeller (*Am. J. Surg.*, 9:444, 1930) analysed

335 cases of sarcoma of the stomach up to and including the year 1929. Balfour and McCann (*Surg., Gynec. & Obst.*, 50:948, 1930) presented the largest series from any one surgical clinic, a group of 54 cases which were treated at the Mayo Clinic from 1908 to 1929. These 54 cases were selected from a total of 4,159 cases of malignant lesions of the stomach, an incidence of 1 sarcoma to 111 carcinomata. Up to the present, close on 400 cases have been recorded, and many excellent accounts together with reports of cases are to be found in the papers by Glenn and Douglas (*Arch. Surg.*, 33:467, 1936), Pack and McNeer (*Ann. Surg.*, 101:1206, 1935), and Conway (*Arch. Surg.*, 33:792, 1936). Most writers are agreed that the incidence in men and in women is approximately equal and that the average age incidence is about 43 in both sexes.

Pathology

Three varieties are described: (1) intra-gastric; (2) extra-gastric; and (3) extensive sarcomatous infiltration of the stomach closely resembling carcinomatous linitis plastica.

Of these types extra-gastric tumours are more common than intra-gastric, while the infiltrating variety, which so closely resembles leather-bottle stomach and which is of much greater malignancy, is commoner than either.

Bertrand, in 70 cases of this disease collected from the literature, found 4 of the intra-gastric, 31 of the extra-gastric and 35 of the diffuse infiltrating type. Metastases are found in about one-third of the cases examined post-mortem and occur in the abdominal lymph glands, in the liver, and in the distant organs, much in the same way as an advanced carcinoma of the stomach.

It should be noted therefore that in approximately 70 per cent of cases of gastric sarcoma the growth is confined solely to the stomach and consequently the results following wide excision of the lesion should prove very satisfactory, as is indeed the case.

The intra-gastric types arise in the submucosa, and in addition to having a limited lateral spread their main direction of extension is toward the capacious lumen of the stomach. They may form large circular submucosal tumours which project into the stomach and sometimes become pedunculated. The mucous membrane may be

tightly stretched over the growth and may ulcerate and bleed severely. When the growth is situated near the pylorus and has a long pedicle, it may conceivably cause a ball-valve pyloric obstruction. The tumour is histologically a fibro- or spindle-celled sarcoma and is of a low order of malignancy. The extra-gastric types originate in the subserosa and grow away from the stomach into the general peritoneal cavity. They involve only a small portion of the stomach wall and often become pedunculated. They frequently attain a large size and form hard circular freely movable abdominal tumours. The pedicle by which the growth is attached to the stomach may become very attenuated and it is even possible for such tumours to be cut adrift from their origin and to become entangled in coils of intestine or to migrate into the pelvis where they may be mistaken for uterine fibroids or an ovarian cyst.

When springing from the lesser curvature they extend in an upward direction toward the liver, often between the layers of the lesser omentum, whereas when springing from the greater curvature they may lie between the layers of the great omentum, fill the lesser sac and possess some of the clinical characteristics of a pseudo-pancreatic cyst. Growths of this type often undergo cystic degeneration, and hæmorrhage into the tumour mass frequently occurs. They often cause confusion in diagnosis and have been mistaken for an enlarged liver, pancreatic cysts, mesenteric cysts, hydatid cysts, cystic swellings of the kidney, ovarian cysts, or uterine fibroids.

On exploratory operation they often appear at first sight to be irremovable owing to the numerous vascular adhesions by which they are surrounded, but after these adhesions have been cautiously separated they can in fact be easily dissected out.

These extra-gastric sarcomatous tumours are often only locally malignant, and the prognosis following their removal is exceedingly good.

The infiltrating types of sarcoma are round-celled growths which speedily extend in the submucosa in a manner similar to that which obtains in carcinomatous linitis plastica, and eventually involve a large portion of the stomach. It may be very difficult both from macroscopic and microscopic examination to differentiate between a diffuse sarcoma of the stomach and a carcinomatous leather-bottle stomach.

Diagnosis

A correct pre-operative diagnosis is very rarely made. On X-ray examination of the stomach, the intra-gastric type is often diagnosed as gastric cancer or simple tumour. As previously stated, the extra-gastric types may be mistaken for cysts or tumours of the pancreas, liver, kidney, ovary or uterus, while diffuse infiltrating sarcomata of the stomach resemble linitis plastica in its clinical, radiological and pathological features.

Treatment

About 70 per cent of these tumours prove to be resectable. With the intra- or extra-gastric forms, extensive resections are, as a rule, unnecessary. After carefully ligaturing off the surrounding adhesions, the extra-gastric growths can be readily freed from their vascular bed. The area of attachment of the pedicle to the stomach is examined to determine as far as possible the amount of stomach wall invaded by the growth, and the extent of the implication will decide the amount of stomach to be removed by wedge excision.

The resulting gap in the stomach is closed with a series of continuous sutures and reinforced with interrupted silk sutures in such a manner that no appreciable narrowing results and there is no tension on the suture line.

This operation of removal of the tumour by wedge-excision of the stomach wall is also applicable to a number of intra-gastric growths which have a comparatively narrow pedicle. Where, however, the pedicle is broad and the tumour sessile, or where a considerable portion of the stomach wall is involved in growth, partial gastrectomy is the operation of choice. The late results are favourable, as is shown by the reports of 38 cases operated upon at the Mayo Clinic, of which 12 remained cured for a period of one to nine years or more. The operative mortality in this series of cases was 13 per cent.

In those cases where multiple sarcomatous growths involve the stomach or where in the infiltrating type it is apparent that more than two-thirds of the stomach is involved, total gastrectomy should be advised.

BENIGN GROWTHS

Benign growths of the stomach are rare. Figures from the Mayo Clinic show that less than 0.5 per cent of gastric tumours are benign. When originating in the body of the stomach they do not, as a rule, cause symptoms until they have attained a considerable size. On the other hand, innocent growths situated in the pyloric segment may at quite an early stage produce pyloric obstruction (fig. 103), or even intussusception or volvulus of the stomach when the growth is forced into the duodenum. In such cases a portion of the stomach wall may become strangulated or may even perforate and give rise to general peritonitis.

All benign growths of the stomach are apt to produce attacks of colicky pain, occasional sharp bouts of vomiting, and hæmorrhage which at times may be very profuse. These tumours may originate in any of the layers of the stomach wall and either remain restricted to one layer or spread beyond it into some other portion of the stomach. They may be sessile or pedunculated. The majority, however, form rounded or flat tumours which project into the cavity of the stomach or into the peritoneal cavity. Most benign tumours develop in the pyloric region and arise from the anterior or posterior wall, showing a predilection for the zone of the greater curvature. They vary in size from $\frac{1}{4}$ -inch to 20 inches in diameter and are all prone to undergo malignant degeneration.

The following pathological varieties are described:

- (1) Myomata; (2) fibromata; (3) adenomata; (4) lipomata and (5) angiomata.

Myomata. These are the commonest innocent tumours and rank third in importance among the growths of the stomach. They are usually single, variable in size, grow principally in the pyloric region, may be sessile or pedunculated, and intra- or extra-gastric. When the fibrous stroma is in abundance they are termed fibro-myomata. They may undergo myxomatous, colloid or sarcomatous degeneration. They do not cause hæmorrhage until their mucous-covered surface becomes ulcerated, when hæmatemesis and more especially melæna may be severe. Those of the extra-gastric type originate in the subserosa and spring from the greater curvature. They may form

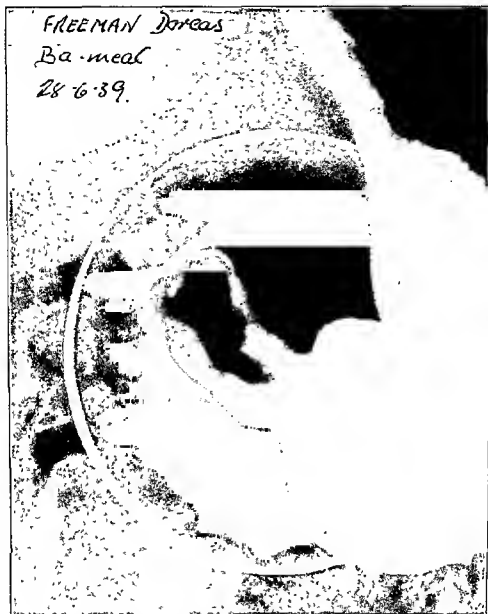


FIG. 103.—GASTRIC POLYP SITUATED IN THE ANTRUM (BULL).

large oval or spheroidal lobulated abdominal tumours, causing the greatest difficulty in diagnosis.

Fibromata. These are exceedingly rare and arise as a rule in the pyloric segment of the stomach. They may be sessile or pedunculated. Histologically they are difficult to differentiate from sarcomata.

Adenomata. These are gastric polypi and may be single or multiple. They may form rounded, sessile or pedunculated tumours. Stewart (*Lancet*, 2:670, 1931) found that 28 per cent of polypi of the stomach were associated with carcinoma, but only 4.9 per cent of carcinomata were associated with polypi. Benedict and Allen (*Surg., Gynec. & Obst.*, 63:79, 1934) in a series of 17 cases of gastric polypi which were causing severe symptoms, found that there was microscopical evidence of potential malignancy in 7 cases, *i.e.*, an incidence of 41.2 per cent. They also state that both Miller and Eliason and Wright, after searching extensively in many microscopical sections taken from adenomatous polypi, found carcinomatous change in 8 out of 23 cases—an incidence of 35 per cent.

When a portion or the whole of the gastric mucous membrane is studded with closely packed adenomata, the condition is termed gastric polyposis. The large polypoid carcinomata probably originate in polypi which are situated in the region of the greater curvature, the tardiness of their growth, their unusual position and the frequent absence of secondary implants in the regional lymphatic glands until the disease is fairly advanced, suggesting this possibility.

Lipomata. These form lobulated, yellow submucous or subperitoneal tumours and give rise to but few symptoms.

Angiomata. These form round, spongy, mobile, sessile, submucous tumours. They are dark red or mauve in colour, often undergo sarcomatous degeneration, and bleed very freely when the surface of the tumour becomes ulcerated.

Symptoms and Signs

It is rare for the symptoms produced by benign tumours of the stomach to be sufficiently characteristic to allow of an accurate pre-operative diagnosis. Symptoms, when present, usually suggest that the patient is suffering from chronic gastritis, chronic duodenitis, chronic peptic ulceration, malignant growth of the stomach, chronic cholecystitis, or some grave form of anæmia. Occult blood tests of the stools are often positive, and a fractional test meal will frequently show that there is a complete absence of hydrochloric acid in the gastric juice.

On X-ray examination of the stomach after the administration of a

barium meal, filling defects which closely simulate those found in cases of cancer of the stomach will often be noticed; but the large rounded pedunculated tumours present no difficulty in X-ray diagnosis, as they produce filling defects which have smooth, clearly defined outlines. While on screening of large tumours of the stomach there is delay in emptying, with small tumours which produce irritability of the stomach the peristaltic waves are vigorous and emptying is rapid.

Treatment

1. Of Large Single Pedunculated Tumours with a Narrow Stalk.

(a) *Intra-Gastric.* After localising the tumour, an incision should be made through the anterior wall of the stomach to expose the growth. The base of the growth should be carefully palpated to determine whether there is any induration, as this, when present, will denote that the tumour is undergoing or has undergone malignant degeneration. If the stalk is small and there is no induration, the tumour can be removed by wide excision of its base together with a margin of healthy adjacent mucosal tissue, the resulting wound in the mucous membrane being closed with a series of interrupted catgut sutures. If, on the other hand, there is definite induration at the base of the tumour, a still wider segment which includes all the layers of the stomach wall is excised together with the tumour.

(b) *Extra-Gastric.* As these tumours often undergo sarcomatous degeneration, a wedge-shaped portion of the greater curvature should be removed around the point of attachment and the opening closed with three tiers of sutures.

2. Of Diffuse Sessile Tumours. When these occur in the pyloric region, partial gastrectomy should be performed. When they occur in the body of the stomach, however, local excision is usually sufficient. Where any doubt exists as to the benignity of the growth, partial gastrectomy is always a preferable undertaking.

3. Of Multiple Tumours. When these are grouped in the pyloric portion of the stomach partial gastrectomy should be carried out. When, however, the greater portion of the stomach is involved, total gastrectomy is the only possible method of dealing radically with the condition.

GASTRIC POLYPOSIS

In this disease a localised portion or the whole of the mucous surface of the stomach becomes studded with numerous closely packed polypi. The disease is exceedingly rare, and Sinclair (*Brit. J. Surg.*, 20:645, 1933) estimated that less than 100 cases had been reported up to 1932. Balfour (1919) considered gastric polyposis to be of exceeding rarity, since in 8,000 operations performed at the Mayo Clinic for gastric lesions there was only one instance of this disease. Brunn and Pearl (*Surg., Gynec. & Obst.*, 43:559, 1926) collected 84 cases and included 5 of their own.

Gastric polyposis is not a pathologic entity, as polypoid masses may be either neoplastic or inflammatory in origin; in fact, many pathologists regard the adenomatous masses as being a secondary manifestation of chronic hypertrophic gastritis. In one variety there are a large number of discrete pedunculated tumours, while in the other the masses appear to be almost confluent, and form a well demarcated plaque.

The disease may be localised or generalised. In the former condition the polypoid masses are segregated in the pyloric segment, whereas in the latter type the whole or at least the greater portion of the mucous surface of the stomach is implicated.

At operation, doughy, worm-like masses may be felt in the stomach, and when the viscus is opened the polypi may be seen tightly packed together, forming either a velvety red plaque or a group of discrete polypi which vary in size from that of a pea to that of a cherry. The mucous membrane is drawn into large folds which superficially resemble the convolutions of the brain. The polypi are papillary adenomata which are composed of columnar epithelial cells arranged in well-formed acini which are supported by lax connective tissue stroma.

As previously stated, they may cause profuse bleeding or undergo malignant degeneration, as has been emphasised by Mills (*Brit. J. Surg.*, 10:226, 1922). The disease may give rise to no characteristic symptoms, but as a rule there is a long history of chronic indigestion, loss of appetite, epigastric discomfort, vomiting of large quantities of blood-stained mucus, and anæmia. Free hydrochloric acid is absent in about 95 per cent of these cases. X-ray examination following the

ingestion of an opaque meal will show the characteristic mottled appearance or numerous interrupted "finger print" filling defects. These irregular defects in the contour of the stomach are due to the indentation of the polypi.

With regard to *treatment*, partial gastrectomy is advised for the localised variety when the tumours are massed in the pyloric segment of the stomach. When, however, the disease is generalised and involves the greater portion of the mucous membrane of the stomach, treatment should be the same as that recommended for chronic gastritis, including frequent gastric lavage, the administration of hydrochloric acid and a bland nutritious diet. In certain cases, especially where repeated hæmorrhages threaten life or malignancy cannot be ruled out, sub-total gastrectomy or even total removal of the stomach should be considered.

CHAPTER 17

SOME OF THE COMPLICATIONS WHICH MAY OCCUR AFTER GASTRIC OPERATIONS

In this chapter I shall consider only four important complications which are occasionally encountered after operations upon the stomach and duodenum. These are:

1. Hæmorrhage.
2. Vomiting.
3. Anæmia.
4. Gastro-jejunal ulcer.

Complications which are common to most abdominal operations, such as pneumonia, pulmonary embolism and infarction, etc., are discussed elsewhere in this book.

HEMORRHAGE

(a) *Immediate*; (i) From the suture line; (ii) from the ulcer bed.

(b) *Late*; (i) From the ulcer bed; (ii) due to gastro-jejunal ulcer; (iii) due to carcinoma of the stomach; (iv) due to gastro-jejunitis; (v) due to acute retrograde jejuno-gastric intussusception.

Following most gastric operations, and particularly those in which some form of anastomosis has been undertaken, the first few ounces of fluid vomited are usually blood-stained, and this is due in most instances to a slight oozing of blood from the suture line in the stomach. Sometimes, however, hæmorrhage may be caused by rough or repeated handling of a fixed gastric or duodenal ulcer which has, on exploration, proved to be irremovable. Should the patient continue to vomit bright blood or become blanched, a serious view of the case must be taken. Post-operative hæmatemesis or mælæna is nowadays a very rare occurrence, as special precautions are taken in suturing to prevent the danger of hæmorrhage at the anastomotic line.

Immediate Measures. If the patient continues to bleed:

(a) The stomach should be washed out through a large stomach tube with warm normal physiological saline.

(b) Morphia, gr. $\frac{1}{4}$, should be injected subcutaneously, and a further injection of gr. $\frac{1}{6}$ to gr. $\frac{1}{4}$ be given if required.

(c) Blood transfusions are given and often prove successful either in arresting the hæmorrhage or in rendering the patient fit to stand a second operation should this prove necessary.

(d) Normal saline solution and 5 per cent glucose is introduced into the circulation by venoclysis or proctoclysis.

(e) The foot of the bed is raised on blocks.

Operative Treatment. If in spite of the above emergency measures the pulse-rate continues to rise steadily and/or the patient continues to vomit bright blood, the abdomen should be opened. The abdominal wall is disinfected with alcohol, the skin sutures are removed, the wound edges are retracted, and tetra-cloths are affixed to its margins. The sutures in the abdominal wall are then snipped with scissors and removed, and the abdominal cavity is opened.

If the previous operation has been a *posterior gastro-jejunostomy*, one of the two following procedures may be adopted:

(a) After carefully packing off the operative field with waterproof squares, the anterior wall of the stomach opposite the anastomotic opening is incised and the edges of this wound are held apart with Allis forceps to permit of an inspection of the interior of the stomach and of the anastomotic line itself. The gastric contents are next aspirated. A tractor suture is inserted at each end of the anastomosis and the gastro-jejunostomy is pulled through the anterior wound in the stomach so that it can be thoroughly inspected. Any point on the suture line which is seen to be bleeding sharply should be underrun and tied, and the parts gently sponged with warm saline solution to make sure that there is no oozing elsewhere along the suture line. If the oozing appears to be fairly general, it is better to oversee the entire circumference of the gastro-jejunostomy with a continuous mattress suture of No. 0 twenty-day chromic catgut. Should oozing still persist at any particular spot, it must be controlled by the insertion of one or two interrupted cross-sutures. The traction sutures are then removed and the anastomosis is allowed to drop back,

after which the anterior wound in the stomach is closed with a three-tier suture.

(b) By the alternative method, the transverse colon and great omentum are drawn through and lifted upward over the edges of the wound and the stitches in the mesocolon are snipped. Rubber-covered enterostomy clamps are next applied to the stomach and jejunum and the anterior row of sutures in the anastomosis is cut through with scissors and withdrawn. The outer margins of the wounds in the stomach and jejunum are retracted, the area is thoroughly cleansed and the clamps are released while the posterior suture line is inspected. A new through-and-through suture is inserted, starting at one end of the posterior suture line and proceeding to the opposite end. It then continues anteriorly, uniting the anterior margins of the stomach and jejunum firmly and evenly in such a way that the risk of further hæmorrhage is eliminated. It is important to loosen the clamps just before the anterior row of sutures is completed. This anterior suture line is further reinforced and invaginated by a continuous Lembert or Cushing suture, after which the margins of the opening in the mesocolon are again stitched to the stomach on each side.

If in the previous operation the original ulcer was not dealt with, and if after the inspection of the posterior row of sutures it is obvious that hæmorrhage is not arising from the suture line, a determined effort should be made either to excise the ulcer or to obliterate it completely by inserting a few deeply placed cross sutures and tying them firmly.

If both these procedures are impracticable, the blood vessels in the vicinity of the ulcer should be underrun and ligated and an attempt made to oversew the ulcer. During the operation all means of resuscitation, *e.g.*, by blood transfusion, etc., should be at hand in case of need.

If the previous operation has been an *anterior gastro-jejunostomy*, enterostomy clamps should be applied and the anterior row of sutures removed to permit of inspection of the posterior suture line. A new through-and-through hæmostatic suture should be introduced, embracing all the coats of the stomach and jejunum, after which the anterior row of sutures is further reinforced and invaginated by a continuous Lembert or Cushing suture. Here, as in the posterior

operation, the clamps should be loosened to permit of inspection when the suturing is half completed and again when it is almost finished.

If the previous operation has been a *gastro-duodenostomy*, the anterior row of sutures is unpicked, any bleeding point is underrun and the posterior layer is reinforced. From this point onward the steps of the operation are precisely similar to those of an ordinary *gastro-duodenostomy*.

Severe hæmatemesis immediately following *partial gastrectomy* is very rare, but when it occurs a secondary operation for its control is a hazardous undertaking and cannot as a rule be recommended. It is wiser in such cases to rely upon continuous drip blood transfusion which so often proves successful.

VOMITING

Persistent vomiting, severe enough to cause anxiety or to necessitate a secondary operation, is today very rare, since the mechanics of gastric operations are so well understood. If the amounts vomited are copious, the pulse-rate is rapid and speedily mounting, and the patient is collapsed, and particularly if grave symptoms arise suddenly after a period of apparently satisfactory progress, there is every possibility of acute dilatation of the stomach being present, and appropriate treatment should accordingly be instituted without delay (see page 502).

Operative Measures. In suspected cases of obstruction following gastric operations, the following palliative measures are always given a trial:

(a) Morphia, gr. $\frac{1}{4}$ is injected and the dose is repeated as required.

(b) No fluids are allowed by mouth.

(c) A small stomach tube is passed into the stomach and the gastric contents are aspirated, after which warm normal saline is used for irrigation. The amounts of fluid withdrawn and the amounts introduced into the stomach should be very carefully measured, as if the quantity withdrawn continuously exceeds that which has been introduced, it is almost surely an indication that there is some mechanical blockage.

(d) Glucose-saline solution is introduced into the circulation by the continuous drip method and by proctodysis in order to combat dehydration.

(e) Pituitrin, $\frac{1}{2}$ to 1 cc., injected intramuscularly at hourly intervals up to five doses, may be effectual in increasing peristaltic movements and thus helping to overcome the obstruction.

(f) An enema should be given to aid the passage of flatus and to relieve any distension which may be present.

It is always an exceedingly difficult matter to decide whether an obstruction exists or not, and if present whether it is serious enough to necessitate a secondary operation, which is always a hazardous procedure. Secondary operations should be avoided, so far as possible, as there are very few experienced abdominal surgeons who have not on some occasion or other undertaken such with subsequent regret. If, however, it is obvious that more fluid is being withdrawn from the stomach than is being introduced, if vomiting proves intractable or if the amount vomited in twenty-four hours exceeds 50 oz., it is clear that the stoma is not functioning and that some secondary operation, undesirable though it may be, must be carried out without further delay.

Secondary Operative Measures. Where obstruction follows any of the *Billroth I* types of repair, the secondary operation recommended is gastro-jejunostomy. If, however, the patient is in a state of marked collapse, Witzel's jejunostomy performed under local anæsthesia is the only possible procedure. Jejunostomy, in addition to supplying a means of feeding the patient, is also very helpful for the reintroduction of the gastric contents which have been withdrawn through the stomach tube. The surgeon should never be in any haste to perform a secondary operation following the Billroth I type of partial gastrectomy, since gastric retention, occasional bouts of vomiting, fairly rapid pulse-rate, and some general disturbance are almost invariable for the first few post-operative days. When once the œdema of the stoma subsides and gastric function is restored, however, subsequent progress is usually uninterrupted, smooth and most gratifying.

If the primary operation has been a *pyloroplasty* or a *gastro-duodenostomy*, the secondary operation for the relief of obstruction should be a gastro-jejunostomy.

After the *Polya* types of *partial gastrectomy* obstruction very rarely occurs; when it does, it may be due to one of the following factors:

(a) Retraction of the anastomosis into the lesser peritoneal cavity.
(b) Adhesion or deformity of the distal loop of jejunum which may become adherent to the under-surface of the abdominal incision.

(c) The employment of too short or too long a jejunal loop. If the former, angulation may result or the taut gut may become compressed even further by the distended transverse colon; if the latter, the vomiting may be due to waterlogging of the afferent limb of the jejunum. Obstructive symptoms are much more commonly seen where too short a jejunal loop has been used, since, after the operation, the stomach retracts upward more than might be expected, dragging the already taut loop with it and further flattening out the jejunum and kinking it at its fixed point at the flexure.

(d) Obstruction of the jejunum proximal to the anastomosis may occur after excision of a large callous jejunal ulcer and is due in some instances to the invagination of too much of the bowel wall into the lumen of the jejunum while repairing an extensive defect following gastric resection for a jejunal ulcer.

(e) Obstruction may result at the stoma through too much of the anterior margin of the cut end of the stomach being turned in, thus leading to the formation of a wide valve. A similar condition may conceivably be produced by turning too much of the stomach wall into the lumen of the jejunum in the region of the greater curvature of the stomach.

Regurgitant vomiting following the *Polya* types of partial gastrectomy should be treated by palliative measures, as outlined above, until the stoma commences to function normally or until it is obvious that a mechanical obstruction exists demanding a secondary operative procedure. If the patient is in extremis, the surgeon will have to be content with carrying out a Witzel jejunostomy; if, on the other hand, the patient appears to have sufficient strength to stand an exploratory operation, the abdomen should be re-opened through the original incision, the wound edges well retracted and the duodenum and the parts concerned in the anastomosis very carefully brought into view. If either the afferent or the efferent limb is adherent to some neighbouring viscus or to the parietes, and has become kinked, it should be gently separated with the finger and prevented

from contracting adhesions by wrapping a portion of adjacent omentum around the affected segment of the gut. If kinking has occurred as a result of marked upward retraction of the small gastric pouch which remains after a posterior Polya gastrectomy, the sutures which anchor the stomach to the rent in the mesocolon should be snipped through with scissors and the opening closed snugly around the proximal and distal limbs of the jejunum, thereby leaving the gastric pouch and the anastomosis high up in the supra-colic compartment.

If the obstruction is due to flattening and kinking after the use of too short a jejunal loop, or if there is any obstruction of the afferent or efferent limb or of the stoma itself, an entero-anastomosis between the two limbs, or even between the efferent loop of the jejunum and the duodenum itself, is necessary.

In cases in which the efferent limb is obstructed in the region of the greater curvature of the stomach or slightly beyond this, an alternative procedure to entero-anastomosis is to instruct the anesthetist to pass a small stomach tube through the nostril or mouth and to guide it into the gastric pouch, and for the surgeon to manipulate the end of this tube through the stoma into the efferent loop wall beyond the site of the obstruction. This indwelling tube is used for feeding purposes after the operation and also helps to dilate the obstructed portion of gut. It should be left in position until normal function is restored.

If the primary operation has been an *anterior gastro-jejunostomy* and this is followed by regurgitant vomiting due to the anastomosis becoming stuck to the under-surface of the abdominal wound or to the abdominal parietes itself, to the afferent portion of the long loop becoming waterlogged, or to the long loop itself becoming compressed by the colon, the secondary operation for relief of the condition should be a small entero-anastomosis between the afferent and efferent loops of the jejunum.

Vicious circle vomiting following *posterior gastro-jejunostomy* may be due to one of many causes, but the following are probably the commonest:

(a) The use of too long or too short a proximal loop of jejunum.

(b) Insecure suturing of the stomach wall proximal to the stoma to the mesocolon, or such technical defects as making the opening in the mesocolon too small or suturing it to the jejunum.

(c) Making the anastomosis at an unsuitable site, *i.e.*, high up in the posterior wall of the stomach.

(d) Atony of the stomach.

It should be remembered that complete inability of the stomach to empty itself after gastro-jejunostomy may be due to atony of the stomach apart from any mechanical operative defects. If the regurgitant vomiting is due:

(1) To the use of too long a loop, this may be corrected by anastomosing the proximal and distal segments of the jejunum.

(2) To the anastomosis being too small, being improperly placed, or to the proximal loop being too short, more often than not it is best to unpick the anastomosis and make a new one rather than to attempt other secondary procedures, the success of which may be very doubtful.

After the tenth post-operative day, disconnecting a gastro-jejunostomy may present considerable technical difficulties and if these appear to be insuperable the surgeon is well advised to be content merely with performing a jejunostomy.

(3) To œdema of the stoma when the mechanics of the operation appear to be satisfactory. In such cases an Einhorn tube should be passed into the stomach and guided through the stoma into the efferent limb of the jejunum. Fluid nourishment and the gastric contents which have been either vomited or aspirated are re-introduced through the tube at frequent intervals. Waltman Walters recommends the performance of a double jejunostomy in such cases, one long tube being passed upward along the efferent jejunal loop and through the stoma into the stomach, the other being made to pass downward into the lower reaches of the jejunum. The uppermost jejunostomy tube collects fluid from the stomach and this can be re-introduced into the lower jejunostomy tube which is also used for feeding purposes.

(e) The kinking or adhesion of the distal loop of the jejunum. Here again a tube passed through the mouth or nostril is manipulated through the stoma into the distal loop of jejunum which is freed of all adhesions. Walters recommended that a gastrostomy be performed and the tube led through the stoma into the efferent limb; but I consider the method here described to be less complicated and equally efficacious.

THE LATE CAUSES OF VOMITING FOLLOWING GASTRIC OPERATIONS

Vomiting occurring months or even years after gastric operations is always a very grave symptom and may be due to one of the following causes:

(a) The formation of a new peptic ulcer in the stomach or duodenum.

(b) Gastro-jejunal or marginal ulceration.

(c) The onset of malignant disease of the stomach.

(d) Peri-gastric or peri-duodenal adhesions.

(e) Contraction of the aperture in the mesocolon following posterior gastro-jejunostomy.

(f) Jejunitis (fig. 104).

(g) Retrograde jejuno-gastric intussusception (fig. 105). Such intussusception may be acute or chronic. So far as I can ascertain from the literature, some 40 cases of acute retrograde jejuno-gastric intussusception have been reported. Adams (*Brit. M. J.*, 1:388, 1935), in a very able article, states that the condition is commoner in women than in men, that cases have been reported as occurring from six days to sixteen years after operation, and that a correct pre-operative diagnosis is very rarely made, the usual being one of acute intestinal obstruction or of bleeding peptic ulcer. He recognises two clinical types:

(1) That in which the patient is suddenly seized with an acute attack of epigastric pain followed by a sensation of severe constriction in the upper abdomen and by severe vomiting. On examination of the abdomen there is visible peristalsis, the waves passing from left to right, and a tumour can often be palpated in the epigastrium. As these cases are diagnosed as acute intestinal obstruction, operation is usually performed without any delay, thus rendering the prognosis favourable.

(2) In the other type, which closely resembles a bleeding peptic ulcer, vomiting is frequent and becomes first blood-stained and then definitely hæmorrhagic. A provisional diagnosis of bleeding ulcer is usually made and the patient receives treatment by medical measures accordingly, thereby leading to delay in operation with a consequently high mortality.

As spontaneous reduction never occurs, unless operation is per-

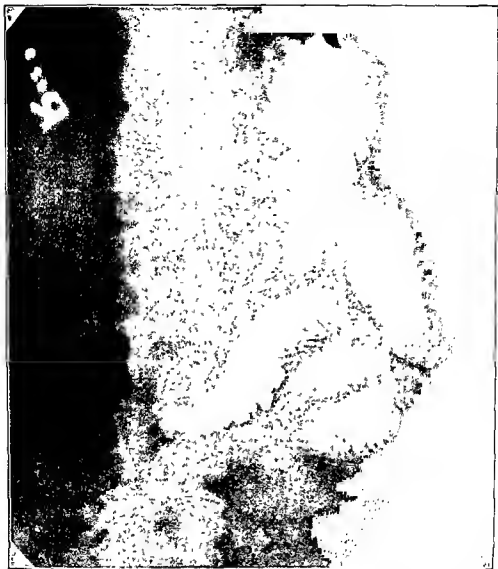


FIG. 104.—SKIAGRAM TAKEN THREE MONTHS AFTER AN ANTERIOR POLYA GASTRECTOMY FOR CHRONIC GASTRIC ULCER.

Note the presence of jejunitis of the efferent limb of the jejunum (Derry).

formed in all such cases, the patients will die within a few days. If, however, operation is undertaken at once, the prognosis is good and some 90 per cent of cases will recover.

From the literature Adams reports 30 patients who were subjected to operation; 9 of these died and 21 recovered; he also reported 1

successful case of his own. Debenham (*Brit. M. J.*, 1:388, 1935) recorded an interesting case of retrograde intussusception of the jejunum following gastro-jejunostomy, and offers some useful suggestions with regard to operative treatment. The following surgeons have also reported cases: Lewisohn (*Ann. Surg.*, 87:543, 1924), Sibley (*Proc. Staff Meet. Mayo Clinic*, 9:25, 1934) and Cameron and Macfarlane (*Brit. J. Surg.*, 23:274, 1935).

The chronic variety is characterised by epigastric distress, colicky pains and intermittent and sometimes severe vomiting occurring at a remote date after gastro-jejunostomy. X-ray examinations are useful in confirming a diagnosis, as the intussusception displaces the barium meal and so produces a marked filling defect. A rounded shadow produced by the ectopic coils of jejunum in the stomach tends to change its position on palpation, and is marked with striations due to the folds of jejunal mucosa. Adams emphasises the following points in connection with this rare complication following gastro-jejunostomy:

(1) Jejunogastric intussusception is a well-established late complication of gastro-jejunostomy for peptic ulcer. It occurs in acute or chronic forms, the former being fatal apart from operation.

(2) Diagnosis is possible, dependent upon the rule: "Where hæmatemesis or obstructive symptoms appear after a gastro-jejunostomy, think of intussusception."

(3) If in a patient with acute intestinal obstruction the following triad is present, then acute retrograde intussusception should be diagnosed: epigastric scar; visible peristalsis, the waves passing from left to right; a palpable mobile swelling about the mid-abdomen.

(4) The chronic form is to be remembered as one of the causes of recurrent vomiting after gastro-jejunostomy. Early radiography is demanded in such cases, and will reveal the intussusception if present and pave the way for a curative operation.

Treatment. The following operative procedures have been practised:

- (1) Reduction of the intussusception.
- (2) Resection of the anastomosis.
- (3) Suturing together the efferent and afferent loops after reduction of the intussusception.

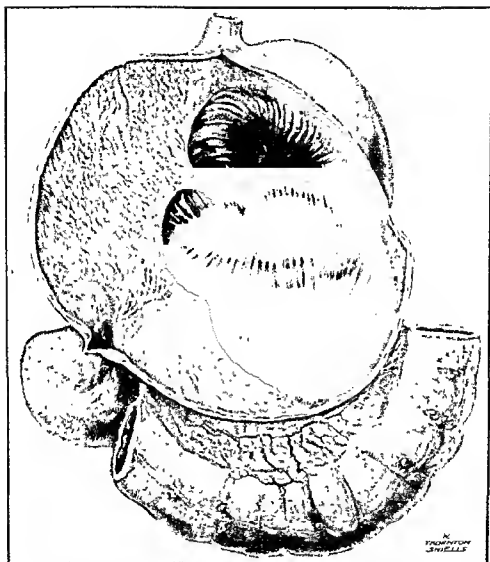


FIG. 105.—RETROGRADE JEJUNO-GASTRIC INTUSSUSCEPTION (ST. BARTHOLOMEW'S HOSPITAL MUSEUM).

(4) Entero-anastomosis, the afferent loop being anastomosed to the efferent loop.

(5) Resection of the anastomosis followed by partial gastrectomy, gastro-intestinal continuity being established by the Billroth I type of repair or by the Polya method.

ANÆMIA

It is well known that anæmia in a mild or grave form may occur after any gastric operation. It is commonly of the hypochromic, microcytic type, and responds very rapidly and satisfactorily to treatment with adequate doses of ferrous salts. A few cases of pernicious anæmia have been reported following gastric operations, and particularly after sub-total and total gastrectomy.

Rowlands and Simpson (*Lancet*, 2:1202, 1932) were able to collect 15 cases of Addison's anæmia from the literature plus 2 cases suffering from sub-acute combined degeneration of the cord. They found that 5 cases occurred after total gastrectomy, 8 after partial gastrectomy, and 4 after gastro-jejunostomy, these operations being performed for cancer of the stomach, for gastric ulcer, and in one instance for duodenal ulcer. The period between operation and the development of anæmia varied from two to fifteen years, the average being six years. Gordon-Taylor carefully investigated the results of 52 cases of partial gastrectomy and found that mild anæmia of a secondary type was present in 8 and severe anæmia in 15; but in no instance did the blood picture resemble that of the pernicious type. Morley quotes very similar figures and is of the opinion that the amount of stomach removed is an important ætiological factor and that, following the Billroth I types of operation, and particularly after Shoemaker's method which he champions, anæmia is very rare.

Hartfall, in a study of 40 cases of anæmia following gastric operations, came to the conclusion that the anæmia may be as severe after short-circuiting operations as after radical gastric excisions. He considers that the amount of stomach removed has no constant relation to the development of anæmia, and that the anæmia is dependent rather upon the functional disturbance produced by the operation in the particular case. But from his figures it would appear possible that anæmia is more common after the Polya types of operation. He

also states that the presence or absence of free hydrochloric acid does not seem to affect the development of this condition.

Gordon-Taylor stresses the fact that anæmia is much more likely to follow extensive resections in women than in men, but that it does not appear to influence the final results as regards capacity for work, and that a large number of patients, although developing anæmia, are very little affected by it. Lake, on the other hand, investigated 51 cases of partial gastrectomy and found the blood counts to be approximately normal in all. Achlorhydria was present in all but one case. Similar results have been obtained by Ogilvie and myself. In my series I have had only one case of severe anæmia which occurred after total gastrectomy for leather-bottle stomach. The patient lived for ten months after operation.

The sum total of evidence would seem to indicate that pernicious anæmia is extremely rare after partial gastrectomy or gastro-jejunostomy, and that mild grades of secondary anæmia may occasionally be seen. It is a wise prophylactic measure, therefore, to prescribe iron, arsenic and copper salts, liver and stomach extracts, hydrochloric acid when achlorhydria is present, and a well balanced diet in all cases following gastric resection.

GASTRO-JEJUNAL ULCER

Garnett Wright suggests that a good title for this condition is secondary peptic ulcer, and that the individual ulcers should be termed jejunal, anastomotic (when occurring at the line of anastomosis) and duodenal (when occurring after gastro-duodenostomy). Other familiar titles are anastomotic ulcer, marginal ulceration, stomal ulcer, and recurrent ulcer. Paterson distinguished two kinds of these ulcers—jejunal, when the ulcer was located in the jejunum, and gastro-jejunal when it was situated at the anastomotic line.

Ætiology and Pathology.—(a) *Incidence.* It is impossible to assess correctly the incidence of secondary peptic ulceration, as the figures given by various authorities range from 1.6 per cent to 34 per cent, and a number of authors in their analyses of cases do not specify whether the ulcers occurred after operations for gastric or for duodenal ulcers. It is, however, universally agreed that gastro-jejunos-

tomy for duodenal ulcer is the operation most frequently followed by anastomotic ulcer.

Moynihan (1919) gave the incidence as occurring in 1.6 per cent of the cases analysed by him; Paterson (1909) 2.4 per cent; Judd (1935) 2.4 per cent; Luff (1929) out of 744 cases was able to trace 21 cases—2.8 per cent; Balfour (1930) 3.26 per cent; Wilkie (1934) 3.5 per cent; Walton (1935) 3.9 per cent; Garnett Wright (1935) 6 per cent; Gatewood (1930) 6 per cent; and Hinton and Church (1934) 16 per cent. Ogilvie (1935) assesses the total incidence at 20 per cent; Friedman (1928) 24 per cent; Strauss (1928) 24 per cent; and Lewisohn (1925) in a series of 68 cases of gastro-jejunostomy for duodenal ulcer re-examined from four to nine years after operation found anastomotic ulcers in 34 per cent. My own estimate of the occurrence of secondary peptic ulceration following gastro-jejunostomy for duodenal ulcer without stenosis is 10 per cent; for anterior gastro-jejunostomy when combined with entero-anastomosis in patients under the age of 40, about 15 per cent. Hurst considers that secondary peptic ulcer is a dangerous and common sequel to gastro-jejunostomy and claims that the number of cases in which the complication occurs after this operation is found to multiply slowly and steadily as such patients are watched over increasing periods. This view is discredited by Judd and Hoerner (*Ann. Surg.*, 102:1003, 1935). Lahey (*Surg., Gynec. & Obst.*, 61:599, 1935) holds the view that the longer the patient continues after operation without developing ulcer, the less likely he is to do so, but that any patient who has a gastro-jejunostomy is liable to suffer from secondary ulcer at some time or another.

Although it has been stated that stomal ulceration is more rare after gastro-duodenostomy than it is after gastro-jejunostomy for simple duodenal ulcer, the incidence is probably about the same. Grey Turner (1921) found recurrences in 4 out of 43 cases, and very similar figures are quoted by others. The complication seldom occurs after gastro-jejunostomy for long-standing scar stenosis of the duodenum associated with anacidity or hypochlorhydria—about 1-2 per cent, or after partial gastrectomy for duodenal ulcer—2 to 3 per cent.

Gastro-jejunostomy performed immediately after primary suture of a perforated duodenal ulcer is especially likely to be followed by

secondary peptic ulceration, some authors placing the incidence as high as 20 per cent.

A particularly pernicious operation is Roux's method in Y, or a combination of anterior gastro-jejunostomy with entero-anastomosis, and neither of these operations should in any circumstances be advised as a primary operative procedure for primary peptic ulceration.

The incidence of stomal ulceration after gastro-jejunostomy for gastric ulcer is rare, probably not higher than 2 to 3 per cent. When this operation is combined with wedge excision of the ulcer or with its destruction with the cautery by Balfour's method, the likelihood of recurrent ulceration is still further diminished to about 1 to 2 per cent. When, however, partial gastrectomy is undertaken for gastric ulcer, provided a sufficient amount of stomach is removed to produce relative achlorhydria, the complication is almost unknown. Anastomotic ulcer may for all practical purposes be considered never to occur after operations for cancer of the stomach. Judd reported one case, and other instances may be found in the literature; but Garnett Wright (*Brit. J. Surg.*, 22:433, 1935) was unable to find a single case out of 436 which were traced, and offers the following possible explanation for the absence of this complication:

(1) That carcinoma patients are immune from secondary ulceration.

(2) That these patients do not live long enough for secondary ulcers to develop; but this is only true in part, since secondary ulcers may appear very quickly.

(3) That symptoms of secondary ulcer are likely to be masked by those of carcinoma.

It is true that the infrequency of secondary ulceration after operations for carcinoma is due to the low acid values or to total absence of free HCl, but possibly also to the diminished peptic activity of the gastric juice. A gastro-jejunal ulcer may therefore be considered to be a complication limited principally to cases of duodenal ulcer in the treatment of which the proximal jejunum has been anastomosed to the stomach.

(b) *Age.* The commonest period of life at which stomal ulceration occurs is between the ages of 30 and 40. Strode (*Am. J. Surg.*, 21:240, 1933) reported a case of jejunal ulceration in a boy of 10 years of age.

(c) *Sex.* Males are more susceptible than females, and the propor-

tion is at least 4:1 for primary ulcer, and approximately 13:1 for jejunal ulcer. In Lahey's series there were 90 males and 10 females.

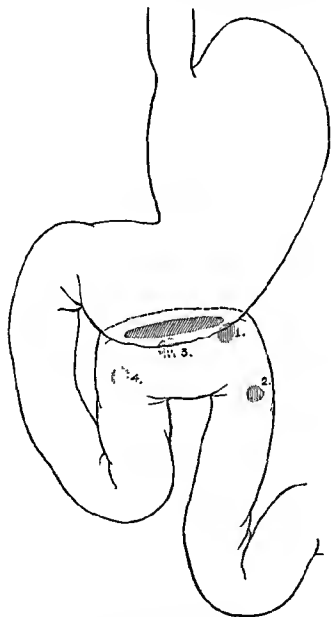


FIG. 106.—JEJUNAL ULCER.

The most frequent sites of ulceration are indicated in this diagram.

(d) *Family History.* The tendency for duodenal ulcer to occur in families has already been mentioned, but, as Hurst has said, a

family history is still more commonly obtained in cases of secondary peptic ulceration. Allen reported a family in which the father and five sons all had an ulcer history with numerous gastric operations. Hurst and Stewart (*Lancet*, 2:805, 1928) found that in 6 of 43 cases there were two or more near relatives who had anastomotic ulcers.



FIG. 107.—JEJUNAL ULCER.

The ulcer has formed a large crater in the distal loop of the jejunum about 1 inch below the gastro-jejunostomy. Note the spastic contraction of the stomach and of the jejunum at the gastro-jejunostomy. The patient, a thin, nervous man, had a posterior gastro-jejunostomy performed for a non-obstructive chronic duodenal ulcer (Bull).

(c) *Site of Ulceration* (fig. 106). These ulcers may occur at the line of anastomosis and extend from this point into the stomach or into the jejunum or into both. When occurring here they may cause considerable scarring and eventually lead to partial or complete stenosis of the stoma. They are not so prone to perforate as true jejunal ulcers, which are considered by some authorities to be the commonest type of secondary peptic ulceration, are usually situated from $\frac{1}{4}$ to 1 inch away from the stoma, and like those in the anterior wall of the duodenum are in a thin unsupported wall and consequently tend to perforate early, though they rarely give rise to any marked degree of stenosis (fig. 107).

Jejunal ulcer occurring in the afferent loop is very rare owing to this loop of gut being constantly bathed in alkaline pancreatic and biliary fluids. Stomal ulcers usually occur singly, but in certain cases they may be multiple.

(f) *Healing*. Spontaneous healing of secondary peptic ulcers is rare, much more so than in the case of chronic gastric or duodenal ulcers. Hurst states that if the condition is recognised early and is strictly treated by medical measures, healing may be brought about successfully in some cases. Such measures, however, should not be persisted with unless there is convincing evidence of rapid and favour-

able response to the treatment, as complications, such as perforation, hæmorrhage, or fistula formation, are all prone to occur.

Pathogenesis.—(a) *The Acid Factor.* It is generally held that the production of these ulcers depends in some way upon the action of the gastric juice upon the stomal margin or adjacent jejunal mucosa, and that the true cause is closely bound up with the cause of primary gastric or duodenal ulcer. In some cases, nevertheless, there may be failure of neutralisation rather than of an excess of acid. Most authors maintain that the presence of free hydrochloric acid is in itself the prime initiating factor, and they explain its absence in certain cases by the fact that chronic gastritis may develop as the result of secondary peptic ulceration. There are a number of clinical and experimental observations which indicate the importance of the acid factor. For instance, duodenal ulcers rarely occur in women, who have, on the whole, much lower acid values than men. Jejunal ulcer is almost unknown after gastro-jejunostomy for cancer of the stomach, a condition which is frequently associated with anacidity. Again, the primary ulcer is duodenal in a large proportion of the cases. In Lahey's series the primary ulcer was duodenal in 90 per cent and gastric in 10 per cent. Hyperchlorhydria is present in from 80 to 90 per cent of cases of gastro-jejunal ulcer. The work of Mann and Williamson and of Vanzant, Alvarez, Berkson and Eusterman support this theory.

(b) *The Infective Factor.* Probably one of the most important contributory causes of secondary peptic ulcer is the presence of infective foci in connection with the teeth, tonsils, nasal sinuses, appendix, or gall-bladder. Infection may also occur from an unhealed chronic peptic ulcer. Bohmansson (1926) drew attention to the possible influence of gastritis in the development of secondary peptic ulceration, and Konjetzny (1930) has shown how frequently gastritis is associated with gastric and duodenal ulcer. An anastomosis between the inflamed mucous membrane of the stomach and the healthy mucous membrane of the jejunum may heal imperfectly and thus predispose to the formation of ulceration. The importance of postponing operation until gastritis, when present, has been successfully dealt with, has already been emphasised.

(c) *Technical Errors.* Technical errors in the performance of the original operation may slightly increase the frequency of the lesion,

but are not the primary causes. It has been thought that the use of non-absorbable suture material accounted for a number of cases, but there is not sufficient proof that the use of an absorbable suture is any safeguard against secondary ulceration, as the complication appears to be equally common after the use of silk and of catgut. It has been suggested that the crushing effect of enterostomy clamps used during the performance of the anastomosis may be responsible for trauma of the mucous membrane, which, under the influence of the eroding gastric juice, may in turn initiate and perpetuate the process of ulceration. Clamps, when employed with ordinary care and skill, cannot, however, be said to play an important part in the production of the lesion, as secondary peptic ulceration occurs with equal frequency when clamps are not employed. Again, as Judd and Hoerner have pointed out, experimental work has repeatedly demonstrated that acute traumatic jejunal and gastric ulcers heal rapidly and show no tendency toward chronicity. Accordingly, we should expect these lesions to be healed by the time symptoms of jejunal ulcer usually appear, *i.e.*, about two years or so after operation.

Excision of the redundant gastric and jejunal mucosa before proceeding with the continuous hæmostatic suture has been blamed by some for the occurrence of secondary ulceration (Grey Turner). It was naturally thought that certain raw surfaces which resulted at the line of anastomosis being unprotected by mucosa came freely in contact with the gastric juice to which they were unaccustomed, with the consequent production of ulceration; but as ulceration appears to be equally common when the redundant mucosa is *not* excised this cannot be said to be an important factor. At one time it was considered that temporary occlusion of the pylorus following gastro-jejunostomy was a factor which increased the incidence of stomal ulceration. There is sufficient evidence to show that temporary occlusion with a silk ligature has very little bearing upon the increased incidence. Walton frequently employs this method, but the incidence of gastro-jejunal ulceration in his cases would seem to be, if anything, lower than that in those reported by many other surgeons who do not adopt this procedure.

An argument in favour of the view that technical errors are responsible for recurrent peptic ulcer was that these ulcers usually seemed to occur within the first year or two after operation. Garnett

Wright in his series, however, found that in only 284 out of 458 cases, *i.e.*, just over 62 per cent, did the symptoms appear within two years. To me this does not seem to favour the view that technique plays an important part in the production of secondary ulcer, as in such a large proportion of cases the onset is so long delayed that it is difficult to believe that technical errors during the primary operation could have any influence. When the complication arises shortly after operation, say, within a month or two, it would appear that in some cases at least technique is at fault, although no one particular error seems to characterise these failures in any large series of cases investigated.

Symptoms and Signs. Pain is the most prominent symptom, and is more severe and recalcitrant than in cases of primary peptic ulcer. Although it is usually localised to the epigastrium, it may be diffused over the whole abdomen, but more often than not the maximum point of pain is slightly below and to the left of the umbilicus. Unlike the perindic pain which is so typical of gastric or duodenal ulcer, it is usually continuous and is less influenced by the intake of food or of alkaline draughts. In certain cases of gastro-jejuno-colic fistula pain may be absent owing to the healing of the ulcer.

Vomiting, which varies in intensity and frequency, takes place in nearly half of the cases. It is often self-induced and is the most speedy method of obtaining relief from pain.

Constipation is common, but when a gastro-jejuno-colic fistula develops, there is usually a very persistent diarrhoea.

Wasting is generally slight at first, but becomes more marked in those cases in which there is fistula formation.

Hæmorrhage is a common complication of gastro-jejunal ulceration, and occurs in about 33 per cent of the cases. Melæna is more frequent than hæmatemesis. One of the more serious forms of anæmia may result from the persistent oozing of blood from the ulcer bed.

On physical examination there is usually tenderness on palpation, especially marked in the epigastrium but occasionally all over the abdomen, particularly just to the left of the umbilicus. The pain and tenderness seem to be diffused over a much wider area than is the case with primary peptic ulcers. In rare instances where recurrent ulceration occurs after an anterior gastro-jejunostomy, the ulcer

may become attached to and actually erode the abdominal wall, producing a tender painful palpable mass.

Radiological Findings. It is difficult to diagnose secondary peptic ulceration by means of X-rays. Usually, however, a diagnosis is suggested by one or a combination of two or more of the following findings: (i) persistent tenderness over the site of the stoma; (ii) gross deformity of the stoma; (iii) stenosis of the stoma; (iv) residue in the region of the stoma; (v) marked delay in emptying of the stomach; (vi) ulcer crater; (vii) gastro-jejuno-colic fistula; (viii) deformity of the efferent loop of jejunum close to the stoma.

Kelly holds the view that skiagrams are not of great diagnostic help, as the ulcers may be very small and the irregularities caused by the gastro-jejunostomy make a positive diagnosis difficult. He writes:

For the past year or two I have had considerable help from the gastroscope. The stoma with the ulceration may quite easily be seen and the state of the stomach mucous membrane (nearly always chronic gastritis) made out. Sometimes, too, an intense congestion of the jejunum, and an angry brownish-red, is clearly seen. With this instrument a positive diagnosis is possible and certain. It is well to do the gastroscopy before the barium meal, for barium seems to stick to the base of an ulcer quite a long time and may easily obscure the ulcer itself.¹

Complications. The following complications may occur:

(a) Perforation; (b) hæmorrhage; (c) fistula.

Perforation of a gastro-jejunal ulcer occurs in 6 to 10 per cent of cases after gastro-jejunostomy, and in 3 to 4 per cent of cases after partial gastrectomy. After anterior gastro-jejunostomy, perforation may occur into the general peritoneal cavity and the symptoms and signs may be quite indistinguishable from those of perforation of a primary peptic ulcer, or the ulcer may become stuck to the anterior abdominal wall, perforate it, and slowly give rise to an external fistula. After posterior gastro-jejunostomy there is a tendency to chronic perforation into the mesocolon, which becomes œdematous and later contracted, a state of affairs which is very prone to produce distortion of the jejunal loop and chronic duodenal ileus.

Perforation may also occur into a neighbouring viscus such as the adjacent transverse colon, giving rise to a gastro-jejuno-colic fistula.

The treatment recommended is simple closure of the perforation.

¹ Kelly, *Lancet*, 1-256, 1939.

or spasm of the pylorus, or in any case in which hyperchlorhydria is associated with rapid emptying of the stomach.

When gastro-jejunostomy is being carried out, the surgeon should, where possible, avoid the use of enterostomy clamps; the proximal jejunal loop must not be too short or too long; the anastomotic opening must be of adequate size, well placed and mechanically correct; he should use catgut for the inner row of sutures, the redundant gastric and jejunal mucous membranes should not be trimmed away; and the suturing must be performed with great care and precision, special pains being taken to ensure absolute hæmostasis and to avoid peritoneal contamination with gastric and jejunal contents, tight suturing and the formation of hæmatomata.

Gastro-jejunal ulcer may, as has been pointed out, occur after partial gastrectomy for duodenal ulcer, but its incidence can be reduced to a minimum by removing at least two-thirds to three-quarters of the stomach in order to ensure the maximum reduction of gastric secretion. Anterior gastro-jejunostomy should not be performed for duodenal ulcer, and following the anterior Polya types of partial gastrectomy anastomosis of the afferent and efferent limbs of the jejunum is not only unnecessary but definitely contra-indicated as the new opening deflects the alkaline juice away from the gastro-enteric stoma. Every possible source of infection in the mouth and pharynx must be removed before the operation, and at operation any associated disease of the appendix, gall-bladder, etc., must be dealt with as seems best in the circumstances.

Following any operation for duodenal ulcer, the patient should be given definite written and verbal instructions with regard to diet, the regular taking of medicines, smoking, etc., and should on the return of the slightest symptoms of indigestion and so forth report at once for medical advice.

Granted all these conditions, this complication would rarely arise in the absence of some major error in technique.

Medical Measures. The medical treatment of secondary peptic ulceration should be undertaken only when there is an opportunity to begin the treatment while the lesion is in an early stage. Medical therapy will not only keep the patient reasonably comfortable, but it will in a certain number of cases eventually permit him to gain control of the condition.

According to Judd and Hoerner, anyone assumes considerable responsibility who persists in treating jejunal ulcers by medical measures in spite of their tendency to be accompanied by complications and regardless of unsatisfactory results. Medical treatment very often permits grave complications to develop. These materially increase the risk of treatment when surgical intervention finally becomes imperative. The patient's delay in seeking advice is another factor contributing to that situation; often he waits until there is a great deal of inflammatory reaction about the ulcer or even until a colic fistula has developed.

Rivers (*Proc. Staff Meet. Mayo Clinic*, 9:663, 1934) has used duodenal extract, a product investigated experimentally by Ivy (*Mod. Med.*, 3:22, 1935), in doses of 60 to 90 grs. for periods varying from one to four weeks as a supplementary measure to the routine medical treatment of this complication, with encouraging results.

Surgical Treatment. The secondary operative procedure in any given case of anastomotic ulcer must of necessity depend upon the nature of the primary operation. Thus:

(a) If the primary ulcer in the duodenum or in the stomach has healed without any scarring or with the minimum amount of deformity and the pylorus is unobstructed, the best procedure is to disconnect the gastro-jejunal anastomosis, to close the openings in the stomach and jejunum, and to restore the alimentary passage to normal conditions (figs. 108 and 109). The anastomotic ulcer is usually excised, but it may be left undisturbed when it is situated in the distal jejunal loop, as following the operation of *restitutio ad integrum* it heals very rapidly.

(b) In other cases of secondary peptic ulceration following gastro-jejunostomy, one of the following operative procedures is advised:

(1) Disconnection of the gastro-jejunal anastomosis followed by Judd's pyloroplasty or Finney's gastro-duodenostomy.

(2) Disconnection of the gastro-jejunal anastomosis followed by gastric resection according to the Billroth I method.

(3) Disconnection of the gastro-jejunal anastomosis, and excision of the secondary peptic ulcer followed by partial gastrectomy by the Polya type of reconstruction.



FIG. 108.—OPERATION FOR JEJUNAL ULCER.

Disconnecting the gastro-jejunoanastomosis. The figure illustrates a stage in the operation when the mesocolon is being detached from the region of the gastro-jejunoanastomosis.

(c) If the primary operation has been a pyloroplasty after the method of Judd or Horsley, the secondary procedure should be partial gastrectomy.



FIG. 109.—OPERATION FOR JEJUNAL ULCER.

The gastro-jejunal anastomosis is being disconnected. In this case there was no evidence of jejunal ulceration and the pylorus was patent. The opening in the stomach was closed, and after trimming away the gastric remnant which was attached to the jejunum, the opening in the jejunum was likewise sutured and the parts restored to normal conditions.

(d) If the primary operation has been a gastro-duodenostomy by Finney's or Jaboulay's method, the secondary procedure should be pyloric exclusion followed by partial gastrectomy by the Polya method.

(e) If the stomal ulcer has followed primary gastric resection of the Polya type, it may prove possible and satisfactory to disconnect the gastro-jejunal anastomosis, excise the ulcer and reconstruct by the Billroth I method. In such cases Balfour warmly advocates the Haberer-Finney type of repair.

In cases of gastro-jejuno-colic fistula, secondary operative procedures will to a great extent depend upon the general condition of the patient, the size of the fistulous tract, the degree of involvement of the colon, and whether or not the pylorus is blocked. One of the three following procedures may be called for:

(a) If the original duodenal ulcer has healed, there is no evidence of pyloric obstruction, adhesions are minimal, the fistulous tract is small and the colon only slightly implicated, the problem may be solved by freeing the colon, closing the small colic puncture, undoing the gastro-jejunostomy and suturing the openings in the stomach and jejunum so that narrowing does not result.

(b) If there is pyloric obstruction or the original duodenal or gastric ulcer is still active, the steps of the operation should be:

(1) Division of all adhesions.

(2) Undoing the gastro-jejunostomy.

(3) Closure of the colic opening and protection of the suture line with adjacent omentum.

(4) Closure of the jejunum. This may be done at right angles to the axis of the jejunum (fig. 110) or, if the jejunum is dilated, the opening may be closed in the longitudinal axis with a two-tier suture, as depicted in figure 111.

(5) Temporary closure of the gastric opening.

(6) Resection of the stomach followed by the Polya type of reconstruction.

(c) At times the colon may be so involved by scar tissue and the fistulous tract so large that simple disconnection may be impossible to perform. In such cases it is better to resect a portion of the colon and to restore colonic continuity by end-to-end anastomosis. In such cases, too, if the portion of jejunum engaged in the anastomosis

is hopelessly contracted, œdematous and inflamed, it is safer to excise this section and to restore jejunal continuity by end-to-end anastomosis.

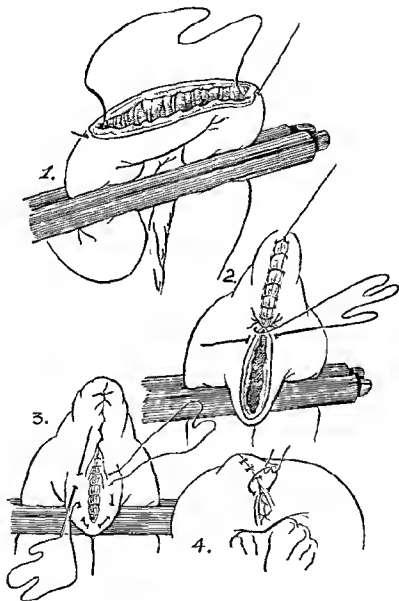


FIG. 110.—OPERATION FOR JEJUNAL ULCER.

The jejunum is being closed at right angles to its longitudinal axis.

In these complicated cases, after the colon has been freed from the anastomosis, it should be drawn out of the wound and wrapped in

mackintosh squares. The resection of the involved colon is best performed after the stomach has been excised and the new gastro-jejunal anastomosis completed.

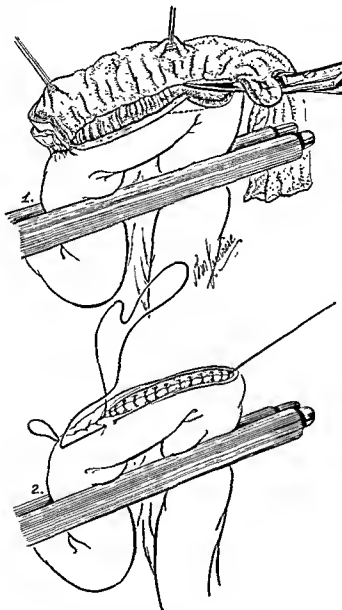


FIG. 111.—OPERATION FOR JEJUNAL ULCER.

In this case, as the jejunum was somewhat dilated, after the remnant of gastric wall had been trimmed away, the margins of the jejunum were sutured in the longitudinal axis with a two-tier suture.

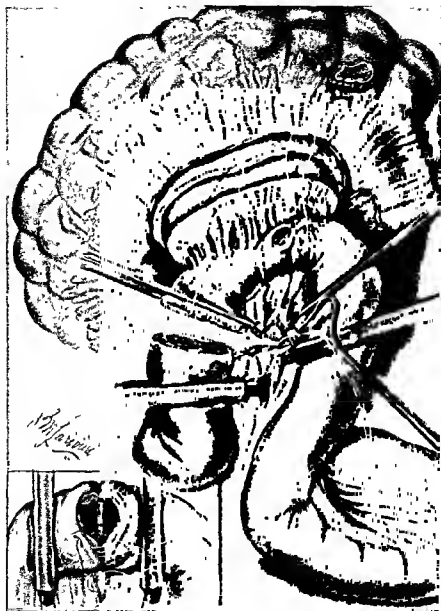


FIG. 112.—OPERATION FOR JEJUNAL ULCER.

The portion of the jejunum engaged in the anastomosis is hopelessly contracted, œdematous and inflamed. This portion of the jejunum is therefore excised and jejunal continuity is restored by end-to-end anastomosis.

Figure 112 shows the method of resecting the jejunum, and figure 113 the Polya operation nearly completed.

Where resection of the involved portion of the colon has proved necessary, it is generally advisable at the completion of the operation



FIG. 113.—OPERATION FOR JEJUNAL ULCER.

(1) Shows the amount of stomach which is excised. This figure also shows the detached jejunal loop clinging to the stomach.

(2) Posterior Polya operation commenced. The first continuous posterior seromuscular suture is being introduced. Note that the proximal jejunal loop just distal to the new jejuno-jejunal anastomosis is applied to the lesser curvature of the stomach, as originally recommended by Polya.

to perform a valvular cæcostomy by Witzel's method in order to remove any strain on the suture line in the colon.

Partial gastrectomy offers the best hope of cure in secondary peptic ulceration, namely 80 per cent. In such cases the posterior Polya operation has an operative mortality of about 10 to 15 per cent, the anterior operation 8 to 10 per cent. By this method at least two-thirds to three-quarters of the stomach is removed in order to ensure a relative achlorhydria and to guard against recurrence of ulceration, for the relief of which any subsequent operation is fraught with considerable technical difficulties and immediate dangers.

PART III

SPLEEN

CHAPTER 1

SPLENECTOMY

INDICATIONS FOR SPLENECTOMY

1. Rupture: (a) Direct injury; (b) indirect injury; (c) spontaneous rupture.
2. Wandering Spleen: with or without torsion of the pedicle.
3. Cysts: *e.g.*, hydatid; Abscesses: *e.g.*, typhoid; New Growths: *e.g.*, lymphosarcoma.
4. Infective Conditions: (a) Bacterial granulomata; (i) tuberculous; (ii) syphilitic; (iii) protozoal—malaria.
5. Blood Disorders: (a) Essential thrombocytopænic purpura hæmorrhagica; (b) hæmolytic jaundice.
6. Metabolic Disorders: Gaucher's disease.
7. Unclassified Conditions: (a) Egyptian splenomegaly; (b) splenic anæmia.

PHYSIOLOGICAL EFFECTS OF SPLENECTOMY

Although the spleen has many functions, it is not essential to life and its removal is not followed by any marked or permanent disturbances. The physiological effects of splenectomy may be summarised as follows:

1. Changes in the Blood. (a) *Red blood corpuscles.* Following splenectomy there is a transient mild anæmia of the hypochromic microcytic type, but this disappears within three to four months. It is exceptional for the erythrocytes to fall below 3 million per c.mm. or the hæmoglobin below 60 per cent. The fragility of the red cells is found to be permanently decreased. Estimation of the hæmoglobin will usually show a moderately low rate, *i.e.*, 60 per cent, during the first month after removal of the spleen, but it slowly rises until about the end of the third or fourth month when it becomes almost normal.
- (b) *Platelets.* The number of platelets is increased temporarily.
- (c) *White Blood Corpuscles.* There is an increase in the total num-

ber of white cells, perhaps to 20 to 40 thousand per c.mm., this being almost entirely due to an increase in the number of the polymorphonuclear leucocytes. The white cell count slowly returns to normal. There may be a slight eosinophilia, and with this there is often an increase in the number of mast cells.

2. **Enlargement of the Lymphatic Glands.** There is general enlargement of all the lymphatic glands in the body, due to compensatory increased hæmatopoietic activity.

3. **Changes in the Bone Marrow.** The yellow marrow in the long bones is gradually replaced by red marrow, this change usually being complete within six months.

4. **Changes in the Reticulo-Endothelial System.** The specialised cells of the remaining portion of the reticulo-endothelial system undergo marked proliferation.

5. **Hypertrophy of Splenuli** (see pages 536 and 537).

6. **An Increase of Iron (Hill and Flack) and Copper (Elvehjem) in the Tissues.**

7. **Regeneration of the Blood.** This, following a severe hæmorrhage, is said to take place more slowly after splenectomy. Such patients will less readily develop jaundice after the absorption of hæmolytic substances. It must be emphasised that there is no evidence whatsoever that following removal of the spleen the resistance of patients to infection is at all diminished.

8. **Diminished Metabolic Activity of the Liver.** As 25 per cent of the total amount of portal blood passing through the liver comes from the spleen, the result of splenectomy will be to relieve the liver of some of its burden, especially when it is cirrhotic.

An alternative to splenectomy is ligation of the splenic artery, and this method may be advised when removal of the organ presents insuperable technical difficulties. When the operation is undertaken, although the temporary results may be flattering, the final results are disappointing in the extreme.

RESULTS OF SPLENECTOMY

The total mortality of splenectomy is about 10 per cent, as evidenced by the figures of the Mayo Clinic where between 1904 and 1934 there were 646 splenectomies performed with 54 hospital

deaths. The mortality varies widely according to the specific condition for which splenectomy is undertaken. For instance, for essential thrombocytic purpura hæmorrhagica it is comparatively low, as is shown by Giffin (*Tr. Ass. Am. Physicians*, 47:218, 1932) who recorded a series of 57 cases with 4 deaths, and Eliason and Ferguson (*Ann. Surg.*, 96:801, 1932) who in reviewing 115 cases reported a death-rate of 7 per cent. In a personal series (*Med. Press & Circ.*, Symposium No. 4, Oct. 1938) of 18 cases (4 acute and 14 chronic) there was only one death—5.5 per cent.

The most encouraging results are obtained in cases of hæmolytic jaundice where the operative mortality does not exceed 5 per cent, and fully 85 per cent of those who recover from the operation remain in perfect health. The same gratifying results cannot, however, be claimed for splenectomy for splenic anæmia and disorders allied to this condition, for although in the early cases the operative mortality is about 15 per cent, in the late cases it may be as high as 30 per cent, and within five years of operation 50 per cent of the patients who survive operation die from gastro-intestinal hæmorrhage or from intercurrent disease.

Rupture of the spleen is yearly becoming a commoner accident, and it has been estimated that in all abdominal injuries its incidence now ranges from 15 to 25 per cent. This may be attributable to such factors as an increasing number of road accidents and aeroplane crashes, and to a greater interest in active sports. It has been computed on good authority that the mortality of ruptured spleen is about 10 per cent, but while this may be so for those cases where the spleen alone is injured and operation is performed promptly and skilfully, it is unquestionably higher where rupture is associated with some concomitant abdominal injury, e.g., torn liver.

The degree of danger in any given case in which injury or disease of the spleen demands splenectomy is dependent upon individual peculiarities and cannot in all fairness be rightly estimated by the mortality percentage basis of any of the statistics which have so far been compiled. These figures, however, are of interest as showing that the immediate mortality of splenectomy is not excessive and is steadily diminishing. For instance, up to 1900 it was 40 per cent, by 1928 it had fallen to 28 per cent, while at present it is computed at 10 per cent. This reduction in the operative mortality is undoubt-

edly due to our increasing knowledge of splenic diseases, to more clear-cut opinions as to the indications for operative interference, and to improvements in our methods of pre-operative investigations combined with a more intensive regime of pre- and post-operative treatment and better surgical judgment and technique.

As I have stated (*Modern Treatment Yearbook*, 1939), the chief dangers associated with the operation are mainly dependent upon the condition of the patient and the type of disease from which he is suffering, in addition to such factors as the size, the friability and the degree of fixation of the organ to surrounding structures, and the hazards which necessarily attend every abdominal operation. In a healthy patient a small non-adherent spleen or one which although enlarged is not encumbered with adhesions, may be excised with little risk. This, however, is not the usual type of organ which calls for removal. The majority of operations are undertaken for conditions associated with some degree of splenomegaly. In many cases the spleen is friable and the blood vessels are thin, stretched to capacity and grossly dilated, or adhesions are present which tether the organ more or less firmly to the diaphragm and adjacent structures. These factors predispose to hæmorrhage, which may be of an extreme degree and most difficult to control. Again, a large proportion of patients are markedly anæmic and asthenic and show other evidence of lack of resistance. It is not surprising therefore that in this type of case operative shock is an immediate danger and post-operative chest complications are relatively frequent.

Splenectomy should be advised only upon some definite indication based upon searching combined clinical, hæmatological and pathological investigations and following a thorough course of pre-operative treatment which may include the giving of blood. For reasons which I have stated elsewhere, blood transfusion, although a life-saving measure in cases of traumatic lesions and in splenic anæmia, is, in my opinion, contra-indicated in cases of essential thrombocytopenic purpura hæmorrhagica and in acholuric jaundice.

THE TECHNIQUE OF SPLENECTOMY

There are many ways of performing the operation of splenectomy, varying according to the technique favoured by the individual sur-

geon and the particular conditions which characterise each case. I propose here to describe the methods which I have myself employed and to lay special emphasis upon the difficulties and dangers which so frequently arise at certain stages of the operation. I have had little reason to vary my technique during the past five years, as reference to my articles on this subject, and especially that which appeared in *Surgery, Gynecology and Obstetrics* in 1934, will show.

Before the operation is commenced, it is important to pass a small stomach tube and to aspirate the contents so as to ensure that the stomach is empty and flaccid throughout the operation. If the stomach is distended with gas and fluid it will push the spleen into an even more inaccessible position, in addition to rendering all intra-abdominal manipulations more difficult and not free from danger inasmuch as the stomach itself may receive some injury when the uppermost portion of the gastro-splenic omentum is being ligated. Therefore this tube which has been introduced prior to the operation is left in situ until the operation is completed, thus ensuring an empty stomach and simplifying the various steps of the procedure.

There are four important stages in the operation:

1. The abdominal incision, involving the question of choice of incision and the exposure of the spleen.
2. Exploration of the abdomen, the freeing of adhesions, and the mobilisation of the spleen and its delivery through the abdominal wound.
3. The methods of securely ligaturing the vascular pedicles of the spleen.
4. Closure of the wound and the steps taken to prevent disruption of the wound or the subsequent formation of ventral hernia.

A large number of incisions have been devised, but in practice only four are in common use today. These are: (a) Midline; (b) paramedian; (c) transrectus or muscle-split; and (d) oblique sub-costal.

The midline incision is the one chosen for cases of suspected rupture of the spleen, liver or stomach, as it is easy to make and can be readily closed, besides affording satisfactory access to the spleen and permitting of inspection of the liver, stomach, duodenum and other viscera of the upper abdomen which may or may not be implicated. If any difficulties are encountered during the operation, the spleen can be more easily approached by dividing the left rectus muscle

transversely through one of its tendinous intersections. On no account should this transverse incision be carried beyond the outer border of the rectus muscle, as extensive transverse slashes are difficult to suture at the completion of the operation and are frequently followed by dehiscence of the wound or by incisional hernia.

The left paramedian incision is the one preferred by most surgeons, at any rate in this country, and is the one which I have used lately for the majority of my cases, as it does not in any way damage the rectus muscle and provided the muscle is well dislocated outward the exposure afforded is excellent. Moreover, if carefully sutured it leaves a sound scar. The main drawback to its employment, however, is that it usually prolongs the operation by a few valuable minutes, which in a desperate case is a matter of considerable importance.

The left transrectus or muscle-split incision divides the left rectus muscle evenly in a vertical plane from a point starting at the costal margin and extending downward to the level of the umbilicus. It is of course readily made and is simple to suture, while the exposure is as good as that afforded by the paramedian incision. The medial part of the muscle, however, frequently atrophies and some permanent weakness of the abdominal wall usually follows the employment of this incision.

The left oblique sub-costal incision begins at the tip of the xiphoid process and proceeds obliquely outward and downward about two finger-breadths below the costal margin, the left rectus muscle and the flat muscles of the lateral abdominal wall being divided in line with the incision. It is, in fact, similar to Kocher's gall-bladder incision on the opposite side and should be employed whenever splenectomy is called for in very obese patients or where it is thought that the spleen may be unduly adherent to the diaphragm and surrounding structures. This incision invariably divides the sixth, seventh and eighth dorsal nerves, but every endeavour should be made to preserve the important ninth dorsal nerve. If skilfully sutured, it is rarely followed by ventral hernia, and in the majority of cases it leaves a very fine and neat scar.

There are four salient features which should characterise all these incisions:

1. They should be large and generous so that there is no hampering of the intra-abdominal manipulations.

2. Special care should be taken to see that wound hæmostasis is complete; neglect of this, owing to the condition of the blood in such patients, may lead to subsequent hæmorrhage or to a dangerous, possibly fatal, oozing.

3. Precautions should be taken to prevent infection of the wound by protecting the margins of the incisions with mackintosh or cellophane squares and by placing large moist ganze packs over these.

4. Closure of the wound should be performed accurately, and tension or stay sutures should be inserted as a precaution against disruption or post-operative ventral hernia, this being by no means an infrequent complication. Where promptness is imperative, the wound may be closed with through-and-through interrupted sutures of silver or bronze wire as so frequently practised by Pauchet.

EXPLORATION OF THE ABDOMEN, THE FREEING OF ADHESIONS,
AND THE MOBILISATION OF THE SPLEEN AND ITS DELIVERY
THROUGH THE ABDOMINAL WOUND

As soon as the abdomen is opened, the first step should be a rapid and thorough exploration of the liver, the gall-bladder, the bile ducts, the pancreas, the stomach, the duodenum, and of other abdominal viscera if conditions permit. If this routine is not conducted prior to the examination of the spleen, some concomitant pathological lesion may be overlooked, thus detracting from the ultimate benefits of the operation. For example, in acholuric jaundice some 60 per cent of cases show the presence of gall-stones or biliary mud in the bile passages as an added complication, and cholecystectomy combined with choledochostomy will be required in addition to splenectomy if a complete cure is to be effected in such cases. Whether the combined operation, *i.e.*, removal of the spleen plus excision of the gall-bladder and drainage of the common duct, should be undertaken in the first instance is a moot point and the decision will of course depend upon the ease with which the splenectomy can be performed and on the general condition of the patient. In severe cases, and particularly where jaundice is pronounced, I advise that splenectomy be undertaken first in order to remove the excessive strain which is thrown upon the bone marrow, this being the most urgent need of the moment. When the patient has sufficiently recovered

from the splenectomy, the gall-bladder is removed, stones—if present—are extracted from the common duct, and drainage of the biliary passages is instituted. Again, in all cases where splenectomy is being performed for splenic anæmia, it is most important to ascertain the condition of the liver, and ancillary procedures, such as ligature of the coronary vein, omentopexy and so forth, may be called for.

In performing splenectomy a careful search should be made for an accessory spleen (or splenculus). These accessory tissues with blood sinuses fall into three groups: (a) The true accessory spleen with blood sinuses and malphigian bodies; (b) hæmal gland with blood sinuses; (c) hæmal lymph gland with blood sinus and lymph sinuses communicating with the blood and lymph systems respectively.

Milroy Paul (*Lancet*, 2:74, 1937) classifies true accessory spleen into two types: In the first the accessory spleen is a constricted part of the main spleen, to which it is bound by a band of fibrous tissue, while in the second type it is a distinct and separate tissue mass.

These splenculi are found near the hilum of the spleen, in the gastro-splenic omentum, in the great omentum, and in the pancreatico-splenic ligament, *i.e.*, in that part of the dorsal mesogastrium which is supplied by branches of the cœliac axis.

It is stated that an accessory spleen is present in 10 per cent of all autopsies. Jolly, however, found 20 cases of accessory spleens in 80 post-mortem examinations in children under 16 years of age, and suggests that they are more common in early life and that possibly they atrophy with increasing years. There is no doubt that in certain splenic diseases they are encountered frequently.

Except when operating for rupture, I have always made a point of searching for an accessory spleen in all cases in which I have performed splenectomy. In a series of 18 consecutive cases of splenectomy for essential thrombocytopenic purpura hæmorrhagica I have found one or more accessory spleen in each of 8 cases, *i.e.*, in 44.4 per cent. Where splenectomy is indicated and an accessory spleen is discovered at operation, it should be excised in all cases except where the spleen is being removed on account of rupture, because these tissues undergo a further maleficent hypertrophy and cause a continuance of the morbid condition for which the splenectomy was

undertaken, and cases are on record in which after splenectomy an unremoved splenculus has grown as large as a normal spleen (Eccles and Freer, *Brit. M. J.*, 2:515, 1921).

It will be noticed that as a result of passing the stomach tube the stomach lies high up, tucked beneath the liver, empty and contracted.

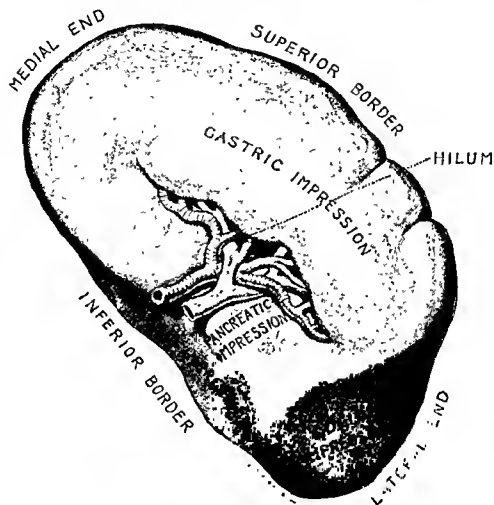


FIG. 114.—GROSS ANATOMY OF THE SPLEEN.

Both edges of the wound should be widely retracted and any adhesions which are found between the spleen and the anterior abdominal wall or between this organ and the diaphragm or colon should be carefully divided.

The further steps of the operation will be governed by the follow-



FIG. 115.—ANATOMY OF THE SPLEEN, SHOWING THE COMPLICATED PERITONEAL REFLECTIONS IN THE REGION OF THE HILUM.

ing factors: (a) The size of the spleen; (b) the presence of adhesions between the spleen and the diaphragm; and (c) the length and mobility of the lienorenal ligament.

The right hand should be passed between the diaphragm and the

spleen to ascertain the size of the spleen, to gauge its consistency, and to determine its degree of mobility (figs. 114, 115 and 116). In cases

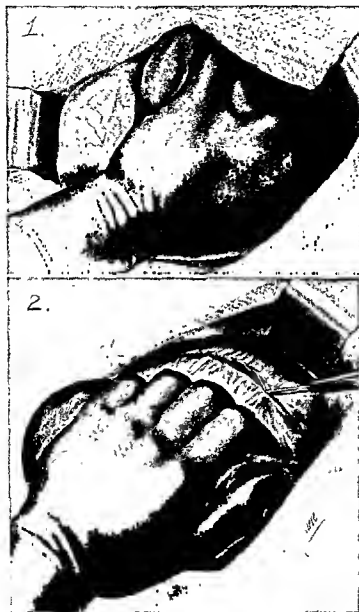


FIG. 116.—SPLENECTOMY.

(1) The right hand is passed between the diaphragm and the spleen to ascertain the size of the spleen, to gauge its consistency and to determine its degree of mobility.

(2) Division of the posterior leaf of the lienorenal ligament.

where the spleen is of normal size or where, if enlarged, it is freely mobile and does not appear to be anchored to the diaphragm by adhesions, the fingers should be swept right round the inferior border to the renal impression and the organ hooked through the abdominal incision.

If at this stage there is any difficulty in delivering the spleen through the incision, the lower two-thirds of the gastro-splenic omentum should be divided between ligatures, the remaining upper third being severed at a later stage in the operation.

Firm retraction on the wound is necessary in addition to levering the spleen medialward in an attempt to deliver it through the wound, thus bringing the posterior aspect of the lieno-renal ligament into view.

With a long knife, the posterior sheath of this ligament is carefully divided, thus rendering further mobilisation of the organ possible (fig. 116 [2]). The underlying areolar tissue and fascia propria are then incised and with the finger or gauze dissection the tissues are cautiously separated, permitting of an even wider freeing of the spleen.

In certain cases where owing to the size of the spleen or to its firm fixation posteriorly it is impossible to see the posterior portion of the lieno-renal ligament, I have divided the peritoneum over the upper pole of the kidney blindly with scissors (fig. 117). A finger is then inserted into this aperture, and by working this finger in an inward and upward direction the main splenic pedicle can be mobilised. This is a most important step, and was first suggested and practised by Wilkie (*Am. J. Surg.*, 340, 1931) and may be regarded as the key to the whole operation, as it is the lieno-renal ligament which binds the spleen down in its hidden retreat in the abdominal cavity. When the lieno-renal ligament is very mobile and adhesions are minimal, it is of course possible to draw the spleen through the abdominal wound without employing this method.

When the spleen is fully delivered—and not until then, the remaining upper third of the gastro-splenic omentum is divided, great pains being taken when clamping the blood vessels not to tear the peritoneum in this region as this would predispose to troublesome oozing of blood, to subsequent hæmatemesis, or even to perforation of the viscus itself (fig. 118 [1]).

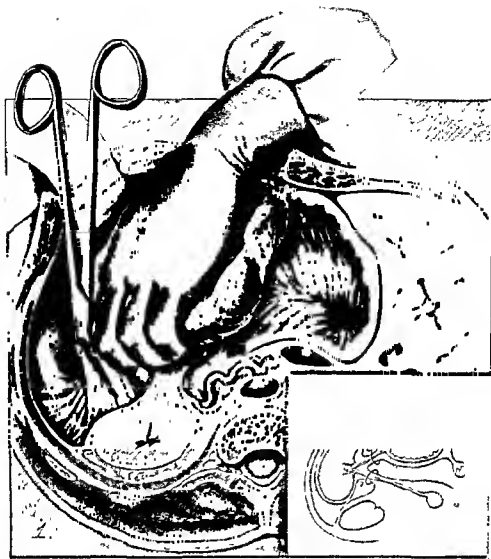


FIG. 117.—SPLENECTOMY.

Blind division of the peritoneum over the upper pole of the kidney to aid mobilisation of the spleen.

Inset: shows (X) the gastro splenic omentum—the first pedicle; and (Y) the lienorenal ligament—second pedicle.

METHODS OF SECURELY LIGATURING THE VASCULAR PEDICLES

The spleen is now quite free and can be drawn even more fully through the abdominal wound, as it is attached only by its main

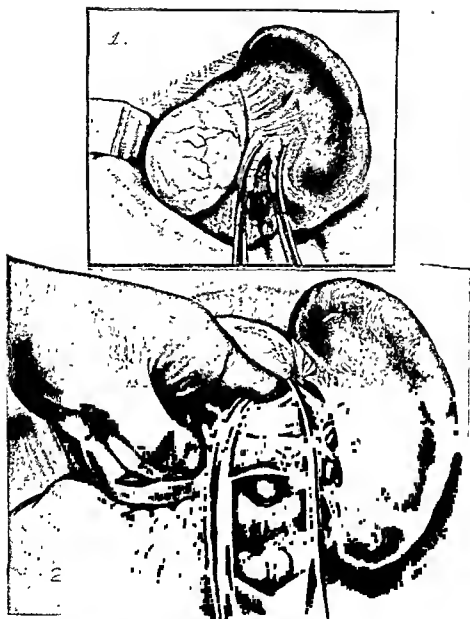


FIG. 118.—SPLENECTOMY.

- (1) Division of the gastro-splenic omentum.
- (2) The three-clamp method. Note the position of the fingers guarding the pancreas while the clamps are being applied.

blood vessels, *i.e.*, the splenic artery and vein. After carefully identifying and dissecting the blood vessels away from the tail of the pancreas, the main vascular pedicle is ready to be ligatured. If the pedicle is very small, as obtains in cases of essential thrombocytopœnic purpura hæmorrhagica, it may be transfixcd with an aneurysm needle and tied off in two places with strong silk, and after clamping distal to the ligature the spleen is removed. If the pedicle is moderately broad, the three-clamp method of Fédoroff should be employed. Before applying these clamps, the index and middle fingers of the left hand are insinuated between the vascular pedicle and the tail of the pancreas in order to protect it while three large hæmostats are applied, side by side, to the pedicle (fig. 118 [2]). These fingers lift the pedicle forward to ensure that the forceps are applied by sight and that in their application no damage is done to the pancreas, stomach or colon.

The spleen is then cut adrift by severing the pedicle with a knife between the middle and distal hæmostats. The inner or medial hæmostat is then removed, thus leaving a groove or crushed area in the pedicle. Two stout catgut ligatures or two strong silk ligatures are applied to this groove and tied firmly side by side, after which each individual vessel distal to this is picked up and ligatured off *seriatim* (fig. 119).

After making sure that there is no bleeding point to be seen anywhere, a portion of the adjacent omentum is drawn over the raw surface of the pedicle and stitched to this area so that none of its surface remains exposed at the completion of the operation.

In cases of marked splenomegaly, the procedure will be different. The gastric surface of the spleen and the gastro-splenic omentum at once come into view when the peritoneal cavity is opened. The spleen in these cases lies very closely applied to the greater curvature of the stomach, the gastro-splenic omentum is vertically lengthened and horizontally shortened, and the blood vessels are enormously enlarged, tortuous and increased in number. This enlargement is particularly prominent near the upper pole of the spleen, and is especially noticeable in cases of splenic anæmia. Each of these blood vessels in the gastro-splenic omentum must be cautiously and individually underrun with an aneurysm needle and ligatured with silk in two places, proximal and distal to the line of section.

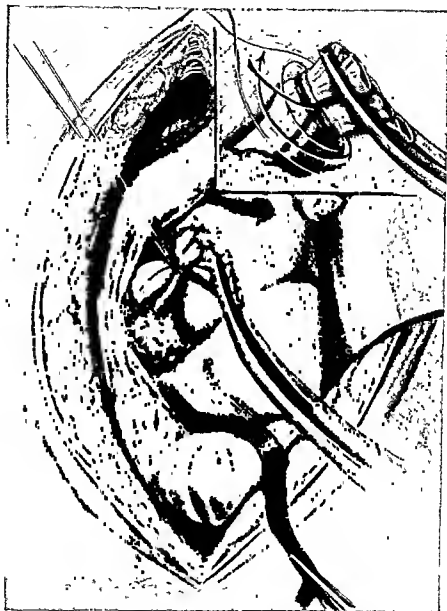


FIG. 119.—SPLENECTOMY.

One method of ligaturing the main splenic pedicle.

After the blood vessels in the gastro-splenic omentum have been dealt with, the right hand should be passed to the back of the spleen. Adhesions in this remote area are investigated, and must in the majority of cases be separated by blunt dissection with the fingers.

Bleeding may be sharp and troublesome at this stage of the stripping, but the breaking down of the adhesions will have to be proceeded with, as it is essential to free the organ posteriorly so that it can be drawn over to the right to display the peritoneum which forms the posterior leaf of the lienorenal ligament. Firm retraction is exerted on the spleen to render the ligament taut so that it can be widely divided to produce greater mobility of the organ, as already described.

A gauze pad soaked in hot saline is crammed against the diaphragm to control bleeding for the time being. The spleen is turned well over on to the abdomen toward the right side to display the posterior aspect of its pedicle and to permit the tail of the pancreas to be separated from the enlarged and sacculated blood vessels which comprise the pedicle of the spleen. Each individual vessel is separated, and with meticulous care an aneurysm needle carrying a strong ligature of silk is passed round it and the vessel is ligatured in two places, fully $\frac{1}{2}$ -inch apart (fig. 120).

W. J. Mayo considers that it is advantageous to tie off the artery first so that some of the blood from the spleen may be drawn back into the circulation. Each vessel that is doubly ligated is then cut between the two ligatures, and this procedure is repeated step by step until the whole vascular sheath has been dealt with. When the splenic veins are the seat of endophlebitis they are particularly soft, and if the ligatures are applied too forcefully they may cut through these veins and initiate a very troublesome hæmorrhage. In these cases it is obvious that on account of the great size of the pedicle the three-clamp method which I have already described is unsuitable.

After dealing with the vascular pedicle, the abdominal pack which has been placed against the diaphragm is removed and any oozing surfaces on the diaphragm are picked up, underrun with a "snaking" suture and tied off. Drainage is unnecessary.

Before the wound is closed and after complete hæmostasis is ensured, a pint or two of warm normal saline or Hartmann's solution is poured into the abdominal cavity. This often gives the patient that extra little fillip at a time when it is most needed.

In some cases of splenic anæmia a state of cohesion rather than of adhesion may exist between the opposing surfaces of the spleen and diaphragm, and this fixation may be so strong and dense that any

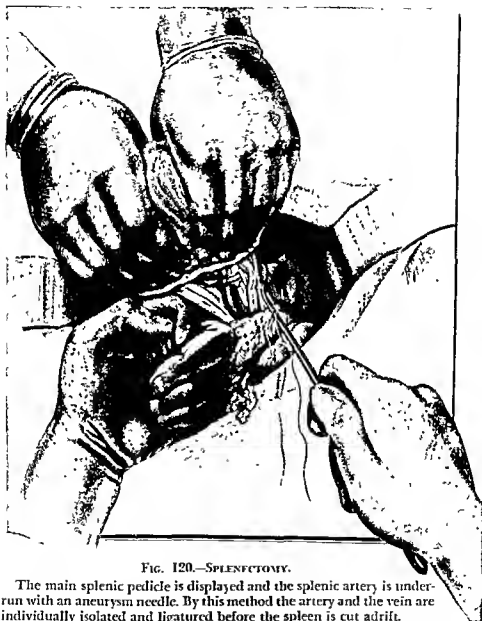


FIG. 120.—SPLENECTOMY.

The main splenic pedicle is displayed and the splenic artery is under-run with an aneurysm needle. By this method the artery and the vein are individually isolated and ligatured before the spleen is cut adrift.

attempt at splenectomy is quite out of the question. In such circumstances therefore, where splenectomy, although indicated, is impossible, it may be wise to ligature the splenic artery behind the stomach at the upper border of the pancreas and in addition to this to tie the left gastro-epiploic artery in continuity at the lower border of the gastro-splenic omentum, close to the greater curvature of the stomach.



FIG. 121.—LIGATURE OF THE SPLENIC ARTERY IN CASES WHERE ALTHOUGH SPLENECTOMY IS INDICATED REMOVAL OF THE ORGAN IS IMPOSSIBLE.

The splenic vein is, of course, not ligatured. In Inset (4) it is shown surrounded by a ligature, but after the artery has been tied this loose ligature is removed.

The splenic artery is best approached by detaching the great omentum from the transverse colon and by retracting the stomach upward, when the artery will be seen and can be isolated some distance away from the hilum of the spleen (fig. 121).

At the completion of the operation the coronary vein should be ligated and in some cases injected with 10 cc. of sodium morrhuate with a view to reducing the incidence of post-operative hæmatemesis. It is well known that hæmorrhage commonly results from rupture of the greatly dilated varices situated beneath the mucous membrane at the lower end of the œsophagus or in the region of the cardia, and it is conceivable that this complication may possibly be minimised by tying and injecting the coronary vein in order to diminish the enormous turgescence by breaking communication with the portal circulation.

Omentopexy, by the "step-ladder" method, which I prefer as a means of permitting additional collateral circulation, is in selected cases a valuable supplementary measure to splenectomy or to ligation of the splenic artery and of the left gastro-epiploic artery in cases of advanced splenic anæmia where removal of the spleen has proved impossible.

CHAPTER 2

CERTAIN SPLENIC DISEASES OF SURGICAL IMPORTANCE

ANEURYSM OF THE SPLENIC ARTERY

An aneurysm of the splenic artery is found in approximately one out of every fifteen hundred post-mortem examinations. Schroeder (*Arch. f. klin. Chir.*, 132:175, 1924) collected records of 20 cases in 32,768 autopsies, i.e., one in 1,600; Garland (*Boston M. & S. J.*, 184:385, 1921) found three instances in 4,100 autopsies (one in 1,400); Muller (1902) discovered nine cases in 10,360 (one in 1,150), while Guy (*Surg.*, 5:602, 1939) stated that he was only able to discover two cases in a series of over 5,000 autopsies (one in 2,500). One of the best articles dealing with this subject is by Anderson and Gray (*Brit. J. Surg.*, 17:267, 1929), who collected 58 cases and wrote a summary of the existent knowledge of the lesion.

At times syphilis, trauma, infectious processes, embolism, arteriosclerosis or malignant growths of the body or tail of the pancreas have been held to be responsible ætiological factors; but an investigation into the majority of the cases which have been reported has disclosed no obvious causes for the disease.

The association of ruptured splenic aneurysm with pregnancy is worthy of comment. Guy states that eight cases he was able to find in the literature constituted about 12 per cent of all the reported cases of aneurysm of the splenic artery.

Most of the cases which have been described have been unrecognised during life, being discovered only at post-mortem examination. Nevertheless, the diagnosis has been correctly made on two occasions prior to laparotomy. Högler (*Wien Arch. f. Med.*, 1:543, 1920) made the diagnosis on the basis of left upper quadrant pain, a lesser curvature pulsating filling defect of the stomach, and a systolic bruit over a palpable tumour mass. Brockman (*Brit. J. Surg.*, 17:692, 1930) also made a correct pre-operative diagnosis and emphasised the value of auscultation in diagnosis.

The symptoms may be vague and suggest cholecystitis or chronic peptic ulcer, but mild epigastric pain is usually the sole complaint until a violent sudden and copious hæmorrhage proclaims the presence of a grave internal catastrophe. The pulsatile tumour situated to the left of the midline in the epigastrium, a bruit heard with the stethoscope, and splenomegaly are usual findings.

Rupture of a splenic aneurysm may give rise to signs and symptoms indistinguishable from those of spontaneous rupture of the spleen.

Treatment. The treatment advised is ligation of the splenic blood vessels at a site proximal to the aneurysm, followed by removal of the aneurysmal sac and the spleen (which is usually found to be enlarged).

SPLENIC ABSCESS

Abscess of the spleen is rarely seen in cold and temperate climates. The frequency with which the spleen escapes abscess formation in infections in general is probably linked up with its abundant content of phagocytic cells and its normal function as the scavenger of stray organisms entering the blood stream. An abscess may, nevertheless, develop during the course of any chronic or acute blood infection and in certain parasitic diseases. It may thus occur: (1) In acute specific infectious diseases, the commonest being typhoid fever; (2) in pyæmia; here multiple abscesses are usually present; (3) in infective endocarditis; here the breaking down of a septic infarct leads to abscess formation; (4) in pneumococcal septicæmia; (5) in certain staphylococcal infections, such as carbuncle and furunculosis; (6) in such tropical diseases as malaria, dysentery, relapsing fever, and in hydatid disease of the spleen; and (7) in injuries.

The possibility of a splenic abscess must not be overlooked in cases of infection and in diseases peculiar to tropical and sub-tropical climates accompanied by high temperature, frequent rigors, localised abdominal pain and tenderness, and signs suggestive of suppuration in the left hypochondriac region and in the base of the left lung.

In the early stages of splenic abscess the symptoms are somewhat obscure, there being no characteristic feature until the abscess has attained a considerable size and has started to stretch the capsule of the spleen or has actually burst and produced a localised peritonitis

in the region of the splenic bed. The condition being rare, the possibility of its occurrence is often overlooked.

In all well-established cases the patient looks gravely ill and there is often anorexia, occasional bouts of vomiting, diarrhoea, asthenia, rapid loss of weight, rigors and high temperature. Pain, localised to the upper left quadrant of the abdomen, is constant and severe, and respiratory excursions on the left side of the chest are restricted and painful. When the abscess is situated in the upper pole of the spleen, the infection may spread through the diaphragm and give rise to pleurisy or empyema. The clinical manifestations in such cases at once suggest subphrenic suppuration or empyema. When the lower pole is principally involved, tenderness below the costal margin may be exquisite, guarding of the muscles on the left half of the abdomen may be marked, but especially so in the left hypochondrium and left post-renal angle, and there may be œdema and pitting on pressure in this area.

A splenic abscess may burst between the convex surface of the spleen and diaphragm and become localised as one form of subphrenic abscess; into the general peritoneal cavity, giving rise to peritonitis; into the left pleural cavity producing empyema; through the abdominal wall; or into the stomach, colon or small intestine.

Treatment. Splenectomy is the best treatment if it can be performed with safety. If, however, the spleen is firmly bound down by dense adhesions and suppuration is extensive, the technical difficulties alone will preclude removal of the organ, and drainage will have to be substituted. Again, if there are localising signs, such as redness of the skin and œdema in the sub-costal area, the abscess should be drained through a judiciously placed incision.

CYSTS OF THE SPLEEN

These are classified as follows:

1. Primary non-parasitic cysts: (a) single; (b) multiple. 2. Dermoid cysts. 3. Parasitic cysts. 4. Hydatid cysts.

Single blood cysts are fairly common and occur chiefly in young adults. The majority of these cysts are due to trauma—hæmorrhagic cysts of the spleen, but in certain cases they may possess a wall of fibrous tissue and may be lined with columnar or cuboidal cells. They

increase slowly in size until eventually they may assume erroneous proportions and may be mistaken for hydronephrosis, ovarian cysts, or cysts of the pancreas. These cysts may be filled with clear, serous or creamy viscid chocolate-coloured fluid, streaked with yellowish flakes of cholesterol. Clinically they cause little or no inconvenience apart from the pressure occasioned by their increase in size. From a surgical point of view they are relatively unimportant.

There are two varieties of multiple cysts of the spleen:

(a) Polycystic. Here the spleen is riddled with numerous small cysts with a similar accompanying condition of the kidneys and liver. Such cysts are always much smaller in number and size in the spleen than in the kidney or liver.

(b) A condition in which multiple cysts occur and are found accidentally at operation or at autopsy. They are of no importance, probably congenital, and are not associated with polycystic disease.

Sherwin, Brown and Liber (*Ann. Surg.*, 109:615, 1939) have reviewed the limited literature on cystic disease of the spleen, and gave an account of an interesting case which occurred in their practice.

Dermoid cysts of the spleen are rare and call for no special comment.

Hydatid cysts may occur in any part of the body and are occasionally found in the spleen (see page 839).

NEW GROWTHS OF THE SPLEEN

These may be classified as:

1. Innocent: (a) fibromata; (b) hæmangiomata; (c) lymphangiomata; (d) mixed varieties, e.g., fibro-angiomata.

2. Malignant: (a) primary; (b) secondary.

Innocent new growths of the spleen are strikingly uncommon and are of little surgical importance. Reports of series of cases are to be found in the papers by Krumbhaar (*Ann. Clin. Med.*, 5:833, 1927), Matas (*Encycl. Med.*, 12:834, 1933) and Grove (*Ann. Surg.*, 105:969, 1937).

Primary carcinoma of the spleen does not occur.

It has been taught that unlike the liver the spleen is very rarely the seat of secondary carcinomatous deposits, but such teaching is

fallacious, as has been pointed out by McMenemey (*Lancet*, 1:69, 1937), who recently made statistical enquiries on this subject, and Warren Shields and Davis (*Am. J. Cancer*, 21:517, 1934), who in a series of 1,140 consecutive cases of carcinoma of all types found macroscopic metastases in the spleen in 1.9 per cent. These metastases occurred most frequently when the primary growth was in the lung (23 per cent of 13 cases) or in the breast (15 per cent of 193 cases). According to the latter authors, the variety of carcinoma which they found most often metastasises in the spleen was the rapidly growing and undifferentiated carcinoma simplex (of 162 cases of carcinoma simplex 20 had metastases in the spleen, 18 of which had their origin in the breast). It is presumed that the growth reaches the spleen via the blood stream, because lymphatic vessels are said not to penetrate the parenchyma and they are infrequent in the capsule.

McNee (1938) states that there is only one primary malignant tumour of the spleen—lymphosarcoma, of which he has only two examples in his collection. Tasker Howard (1929) was able to collect 116 cases of primary sarcoma of the spleen. The ultimate results of splenectomy for sarcoma were shown to be unsatisfactory, as the majority of patients died of metastases within eighteen months. Some unexpectedly good results did, however, follow the removal of the spleen, and this is confirmed by W. J. Mayo who has reported a number of five-year cures.

TUBERCULOSIS OF THE SPLEEN

This may be primary or secondary. Tuberculosis of the spleen is often seen in cases of generalised tuberculosis, the spleen in such cases usually being moderately enlarged and studded with numerous grey miliary tubercles, most marked beneath the capsule which may, in prolonged cases, grow by fusion into small discrete yellow areas of caseation. Seldom is there time for softening and liquefaction to occur. At post-mortem examination healed tubercles are found in the organ comparatively frequently in cases in which tuberculosis has occurred elsewhere in the body.

Primary tuberculosis of the spleen is rare. Winternitz has recorded 51 instances of extensive tuberculosis of the spleen without marked disease of the other organs, but he noted only one in which the spleen

alone was affected (Pool and Stillman). There may be in these so-called primary cases one solitary abscess, diffuse fibrosis and scarring, and calcification with multiple nodules, but it is a more common happening to find the spleen riddled with small breaking-down caseous masses.

Pether (*Lancet*, 2:1423, 1937), in one of the most comprehensive articles dealing with this subject, reviews the literature, describes two personal cases, and offers many useful suggestions with regard to treatment. Splenectomy is often justifiable, and Hawkes (*Ann. Surg.*, 1:56, 1919) was one of the first to report a successful case. McNee (*Lancet*, 1:1069, 1931) points out that taking all cases of splenomegaly, those in which splenectomy offers the best hope of cure far outnumber the others, and if we merely consider the splenic enlargement of unknown ætiology this is likely to be equally true. The existence of tuberculosis or other disease in other organs of the body does not inevitably negative surgery.

The operation should be approached with reserve in the presence of polycythæmia which has been a marked feature in some of the reported cases.

SYPHILIS OF THE SPLEEN

In congenital syphilis there may be a diffuse enlargement of the spleen due to interstitial splenitis, or multiple gummata may be present. In the secondary stage of syphilis the spleen is frequently enlarged as the result of diffuse interstitial inflammation of the organ. In tertiary syphilis, splenomegaly may occur as the result of interstitial changes or from the formation of localised gummata. In some cases of tertiary syphilis of the spleen the symptoms, signs and blood pictures may closely resemble those of splenic anæmia.

Treatment. Anti-syphilitic measures in cases of syphilitic splenomegaly should be persevered with for as long as possible. In anomalous cases of splenic enlargement which do not conform to any known type, a short intensive course of anti-syphilitic treatment should also be given a trial, as some of these cases may respond to such measures. In intractable cases, and specially where the Wassermann reaction is persistently positive in spite of a carefully planned regime of treatment and in which the patient in addition to suffer-

ing from splenic enlargement, is very anæmic, debilitated and obviously retrogressing, splenectomy, as advised by W. J. Mayo, is well worth undertaking. He has recorded 10 such cases, five of which showed remarkable improvement after splenectomy, the Wassermann reaction which before was persistently positive speedily became negative and the patients were restored to good health.

MALARIAL SPLENOMEGALY

In tropical countries malaria is the commonest cause of splenic enlargement. It was customary in the past to advocate splenectomy in certain cases of malarial splenomegaly, as the enlarged spleen which obtained in these cases was very prone to injury, torsion of the pedicle was said to be a common occurrence, and the removal of the organ permitted the resumption of active work in cases in which medicinal measures had failed to produce any improvement. We now know that many "malarial spleens" which had failed to respond to anti-malarial treatment were due to kala-azar. It is now exceedingly rare to have recourse to excision of the spleen for malaria alone, for, except in cases of rupture which demand immediate surgery, medicinal treatment combined if necessary with radiation so often proves entirely successful.

WANDERING SPLEEN

This is a rare condition, as shown by the reports that of 646 splenectomies performed at the Mayo Clinic up to 1934, only two were for wandering spleen (Giffin). According to Adkins (*Ann. Surg.*, 107:832, 1938), Irvin Abell analysed 95 cases collected from the literature up to 1933.

The causes of this condition may be:

1. Congenital. Here the ectopic position of the spleen is due to absence of the supporting phrenico-colic ligament.

2. Acquired. (a) Trauma; as a result of direct or indirect injury the suspensory ligament of the spleen may give way or become stretched and elongated. (b) Splenomegaly; here the weight of the spleen may stretch the supporting peritoneal folds and the organ become unduly mobile.

The wandering spleen may be found in the thorax in cases of diaphragmatic hernia; it may wander into any part of the abdominal cavity, showing a predilection for the left iliac fossa; into the hollow of the pelvis; or even into a large hernial sac.

In the migrations of the spleen the following complications may occur: twisting of the pedicle; engorgement and consequent enlargement; hæmorrhagic cystic formations; atrophy; or "dislocation." The movable spleen is said to be dislocated when as a result of localised chronic peritonitis it becomes fixed in an abnormal position and remains so.

Clinically there is usually no difficulty in recognising the condition, as the wandering spleen has a characteristic shape and generally lies in a superficial position. It may often be pushed back into its former bed in the abdominal cavity. Occasionally, however, it may be mistaken for a uterine fibroid with a long pedicle; an ovarian cyst or growth of the ovary; a pregnant uterus; a polycystic kidney; a hydronephrotic kidney; or even carcinoma of the stomach or of the splenic flexure. The symptoms are usually mild and may include a dull ache in the epigastrium from engorgement, flatulent dyspepsia from the dragging on the stomach, pressure effects, and a variety of symptoms akin to those caused by movable kidney. When torsion of the pedicle occurs, the symptoms are acute and may resemble those of a severe abdominal catastrophe. There is sudden agonising abdominal pain, prostration, vomiting and distension, in fact a combination of symptoms frequently seen in a case of twisted ovarian cyst. A diagnosis may be impossible until the abdomen has been opened.

The acute symptoms are due to thrombosis of the blood vessels of the pedicle which have long been twisted, rather than to rotation of the pedicle itself which, as a rule, is a slow process. As soon as the blood vessels in the pedicle thrombose, the spleen becomes a massive infarct and localised peritonitis ensues. It may in addition become gangrenous, slough, or produce a localised abscess or generalised peritonitis.

Treatment. A few cases have been treated by splenopexy, but this operation has little to offer with regard to permanent relief of symptoms, and splenectomy is the operation recommended for all cases of wandering spleen, whether complications are present or not.

GAUCHIER'S DISEASE

This is a rare, congenital, familial disturbance of lipid metabolism, characterised by splenomegaly, hepatomegaly and lymphadenopathy, marked chronicity, secondary anaemia, hæmorrhagic diathesis, pigmentation of the skin, and changes in the bones. It was originally described by Gaucher in 1882, who regarded the condition as a primitive endothelioma of the spleen. Mandlebaum (*Am. J. M. Sc.*, 157:366, 1919), Lieb (*Ztschr. f. physiol. Chem.*, 140:305, 1924), Epstein (*Biochem. Ztschr.*, 145:398, 1924), and Pick (*Am. J. M. Sc.*, 185:453, 1933), as a result of extensive research work, founded the present conception of the disease, which is now regarded as a disturbance of lipid metabolism in which the Gaucher substance—kerosine—is deposited in certain cells of the reticulo-endothelial system.

The onset is insidious, there being no sign of the disease at birth. The first indication of its presence may be the accidental discovery of an enlargement of the spleen, osseous complications, or symptoms referable to the hæmorrhagic diathesis.

According to Pack and Silverstone (*Am. J. Surg.*, 41:77, 1938) the disease affects mainly children and young adults. In a review by Hoffman and Makler (*Am. J. Dis. Child.*, 38:775, 1929) 51 per cent of the 89 reported cases were under 25 years of age, 30 per cent were under 5 years, and 16 per cent were under 1 year. The youngest case recorded (Siegmund) was one week old, and the oldest (Hunter and Evans) was 60.

The course may be acute in children, but it is on the whole chronic in adults. In the average case the condition is slowly progressive, but there are instances where the patient has lived for twenty years or even more after the disease was first discovered. The disease is commoner in females than in males in the proportion of 2 or 3 to 1, and is congenital and familial. In about one-third of the cases examined by Pick, several members of one generation were affected, but the disease was limited to this generation only. As many as four cases in one family have been reported.

Splenomegaly is the most characteristic feature of this disease. The spleen undergoes a slowly progressive enlargement and in the late stage may fill the greater part of the abdominal cavity. Some of the

largest spleens ever seen belong to this group. The average weight of the normal adult spleen is about 7 oz. This should be compared with the Gaucher spleen which I removed in 1931 from a girl, aged 2 years and 7 months. This spleen when received in the laboratory weighed 39 oz. The patient, who lived for nearly six years following operation, eventually developed extensive infiltration of the lungs with the Gaucher substance. Marklen, Waitz and Warter (*Ann. de méd.*, 33:97, 1933) reported a case of Gaucher's disease in which Gaucher cells were found in the sputum.

As a rule the liver slowly enlarges as the disease progresses. Nevertheless in the more chronic varieties, and especially in elderly patients, following splenectomy the swollen impregnated liver may remain stationary for several months or even years; but in children the tendency is for it to grow rapidly until eventually it occupies the greater portion of the abdominal cavity. There is no ascites.

The blood changes are fairly constant; there is usually a moderate hypochromic anæmia, and leucopenia, due to diminution in the polymorphonuclear leucocytes or lymphocytes, is stated to be a common occurrence. It is certainly present in the majority of cases, but not in all. After splenectomy there is frequently a leucocytosis. This is well shown in the case which I have described elsewhere, in which the white blood cells rose from 2,200 immediately before operation to 11,000 six days after splenectomy, and nearly three years later a white count of 15,000 was recorded. Thrombocytopenia is present in cases in which splenectomy is not performed. After removal of the spleen the platelet count mounts rapidly, often to a normal figure, as I have shown. This pre-operative platelet deficiency may in part account for the hæmorrhages from the gums, purpura, and hæmaturia so frequently seen. After splenectomy such bleeding is very rare and the blood picture shows an all-round improvement. In only one case, that of Potter and McRae (*Am. J. M. Sc.*, 185:92, 1933), has there been any definite improvement both in the blood picture and in the general condition of the patient following the administration of liver extract and iron.

The characteristic Gaucher cells have never been demonstrated in the blood stream at any time, although they have been obtained from the spleen by puncture and from the marrow by sternal puncture (see page 587).

Pigmentation of the skin is an expression of a general hæmochromatosis which is constantly present in Gaucher's disease and which becomes more marked as the disease progresses. The peculiar diffuse or blotchy pigmentation, limited principally to the face, neck and hands, imparts a greyish or yellow-brown to ochre tone.

There may be brownish-yellow, wedge-shaped pinguecula-like thickenings of the ocular conjunctivæ, but this is present in only some 20 per cent of all cases.

The osseous changes observed in Gaucher's disease are usually of three varieties: (a) flask-like expansion of the lower ends of the long bones, and especially of the femora, accompanied by a dull ache or even sharp pain; (b) localised swellings over the bones, suggestive of a localised periostitis or abscess; (c) pathological fracture.

Children suffering from the disease are prone to spastic irritative contraction and tremors of central type.

The lymphatic glands become impregnated with the Gaucher substance, and this particularly applies to the abdominal lymph glands. But Donovan (*Surg. Clin. N. Am.*, 11:517, 1931) recorded a case in which a diagnosis was made after excision and biopsy of an enlarged inguinal gland which contained Gaucher cells.

Disturbances of the organs of internal secretion, as noted by Norbertenzer, are by no means infrequent. Cases of dwarfism, infantilism and general dystrophies have been seen in association with this disease.

The outstanding feature is the presence of Gaucher cells which are found in the malpighian bodies, in the venous sinuses of the spleen, in the bone marrow, in the sinusoids of the liver and in the lymphatic glands. They are in all probability modified reticular cells—histiocytes. Collections of these peculiar, large (about 20 to 80 μ in diameter), clear, vesicular cells with their small nuclei (1 to 20 in number) will be seen in the sections, grouped together and often in alveolar arrangement. The cytoplasm under a high magnification appears wrinkled. This wrinkling is due to a mass of minute threads woven together in an irregular network. The wrinkles are the remains of the spongioplasm in the interstices of which kerosine is stored. The nuclei may be single or multiple, more often than not numerous, even as many as twenty sometimes being crammed into one cell.

A diagnosis is made when an enlarged spleen is discovered in a patient who has a peculiar ochre-like tint of the skin and in whom there is usually hepatomegaly without ascites, flask-like expansion of the lower ends of the femora, a slight degree of pyrexia, leucopænia, hypochromic anæmia, and on sternal puncture the finding of Gaucher cells. Death usually results from cachexia, rapidly progressing anæmia and severe hæmorrhages, broncho-pneumonia or phthisis. Splenectomy itself must be considered a cause of death in this disease, as the mortality of the operation is about 20 per cent, most of the deaths being due to post-operative shock or hæmorrhage. Up to the present date about 110 cases have been reported.

Treatment. From the very nature of the disease, which is a congenital anomalous defect of constitution, it will be evident that there can be no specific treatment for Gaucher's disease. The anæmia which is invariably present does not respond to such measures as the exhibition of iron and liver, blood transfusions have no influence on the course of the disease, while deep X-ray therapy or radium, although given a trial in many cases, has produced little or no effect. Splenectomy offers the only hope of palliation. It prolongs life, it improves the patient's general health, it is associated with very marked changes in the hæmorrhagic diathesis, with return of blood platelets to normal and greatly diminished tendency to spontaneous hæmorrhages; the anæmia is also improved, the pigmentation of the skin decreases, and the patient is rid of the discomfort arising from the presence of a large intra-abdominal tumour.

I have said that life may be prolonged by removal of the spleen in this disease. This is especially true for patients in the fourth and fifth decades of life, and many instances have been recorded of operations performed during this period after which the patients have survived for many years. In infants and young children the prognosis following splenectomy so far as duration of life is concerned is, of course, less promising, and the majority of these subjects die from an extension of the disease to such vital organs as the liver and, as Myers (*Brit. M. J.*, 2:8, 1937) has shown, to the lungs. The best that can be hoped is that the patient may live for five years following splenectomy.

SPLENIC ANÆMIA AND BANTI'S SYNDROME

The term splenic anæmia was first used by Griesinger and Gretzl (*Berl. klin. Wchnschr.*, 2:22, 1866) for cases of anæmia associated with chronic splenomegaly, but the first systematic description of the disease was given by Banti (*Arch. sculo. Anat. patol. Firenze*, 2:53, 1883). Banti described the "symptom-complex and the anatomo-pathological complex" which has since been known as Banti's disease (*Semaine med.* 14:318, 1894; *Beitr. z. Path. Anat.*, 24:21, 1898; and *Folia hæmatol.*, 10:33, 1910).

Banti divided the disease into three stages:

1. **The Pre-Ascitic Stage** (splenic anæmia). A characteristic feature of the disease is the progressive enlargement of the spleen. In this stage the splenomegaly is associated with a moderate degree of secondary anæmia. The red blood cells vary between 3 and 4 million per c.cm., the hæmoglobin value is low—about 60 per cent, and the colour index is reduced to about half. Leucopænia affecting the granular cells is the rule. This stage generally lasts from three to six years, but may continue for as long as twelve years. Toward the end of this stage the liver becomes palpable.

2. **The Intermediary Stage.** This usually lasts for a few months and is characterised by gastro-intestinal disturbances, by progressive enlargement of the liver, and by severe anæmia with a marked tendency to hæmorrhages of all kinds but especially recurrent hæmatemesis. The urinary output is diminished, and the urine contains bile pigments and urobilin.

3. **The Ascitic Stage.** Ascites appears, the liver slowly shrinks until it becomes impalpable, and anæmia is more pronounced. Death commonly takes place within six months, usually from hæmatemesis, hepatic insufficiency or intercurrent disease.

The ætiology and several factors relating to the pathology of this illness are still unknown; therefore, whenever the ætiology of any splenic condition resembling Banti's disease has been discovered as a combined result of clinical, pathological and serological investigations, such a disease at once passes out of this category. McNee writes:

In any collection of enlarged spleens, however, obtained from patients in Britain, there remain a large number which do not fit into any of the known diseases or categories which have been mentioned. In the writer's own extensive

collection there are a large number of these labelled for the present "splenomegaly of uncertain origin," and many of them are derived from patients with the *clinical* picture commonly referred to as splenic anæmia (Banti's disease, Banti syndrome). This writer has made many attempts to sort out this group, both clinically and pathologically, but so far with very incomplete result. Nor is it possible yet to be certain whether hepatic cirrhosis, so often found at necropsy on these cases, precedes or is always a sequel to the splenic enlargement, although this point is manifestly of critical importance in relation to the operation of splenectomy. All that can be said with certainty is that enlarged spleens, apparently from the same clinical group of splenic anæmia, all show a generalised fibrosis (probably due entirely to chronicity) but otherwise *much divergence in structure*. In some, proliferation of the reticulo-endothelial tissues is so marked that the pathological description of "reticulo-endotheliosis of the spleen" is warranted; in other equally large spleens the pathological changes seem quite different. It is obvious that, for the present, this large indeterminate group of "splenomegaly of uncertain origin" must remain a puzzle.¹

Treatment. Splenic anæmia may be treated by medical measures or by removal of the spleen. The final results of either form of treatment are often on the whole disappointing. Medical measures include: Rest in bed for long periods, a nutritious diet with the liberal administration of sugar, intramuscular injections of iron and arsenic together with large doses of ferrous salts by mouth, blood transfusions, and radiation of the spleen by radium or X-rays. Iron is given in the form of Bland's pills, in doses of from 40 to 100 grs. daily over long periods, or as *mist. ferri et ammon. cit.*, and in some 70 per cent of cases so treated marked improvement in the blood condition may be anticipated.

Splenectomy is universally recommended as the treatment of choice during the first stage of the disease and occasionally during the so-called intermediary stage. Howells (*Lancet*, 2:1320, 1938), as the result of his investigation of a large series of cases at the London Hospital, is very sceptical with regard to the value of splenectomy in this disease and considers that the expectation of life in the different stages of the illness is little altered by operation. He writes:

An analysis of the results of treatment in 91 cases of splenic anæmia or Banti's syndrome shows that splenectomy does not improve the expectation of life nor prevent the progress of the cirrhosis of the liver or of the anæmia, or

¹ McNee, *Med. Press & Circ.*, Symposium No. 4, 1938.

the occurrence of hæmatemesis, and there is therefore no logical reason for retaining it as a routine. It may be justifiable to remove a spleen that is causing severe pain, but the operative risks must be considered.²

His figures show that 22 (43 per cent) of 51 cases treated by splenectomy and 20 (46 per cent) of 43 cases treated medically improved. The results according to the stage of the illness when treatment began were as follows:

In the *first stage*: 14 cases (56 per cent) improved after splenectomy and 10 (63 per cent) improved after medical treatment:

In the *second stage*: 3 (30 per cent) improved after splenectomy and 7 (39 per cent) improved after medical treatment:

In the *third stage*: 5 (31 per cent) improved after splenectomy and 3 (33 per cent) after medical treatment.

The mortality of splenectomy for splenic anæmia in early cases is about 10 to 15 per cent, but in late cases it may be as high as 30 per cent. The dangers of extensive portal thrombosis following splenectomy in other than thrombocytopænic cases have been stressed by Rosenthal (*J. Am. M. Ass.*, 84:1887, 1925) and Howel Evans (*J. Pathol. & Bacteriol.*, 31:815, 1928). Pemberton shows that of 167 patients with splenic anæmia and Banti's syndrome who were subjected to splenectomy at the Mayo Clinic, 16 died in hospital—an operative mortality of 9.6 per cent.

Of the 151 patients who survived the immediate effects of the operation, 80 are known to be living, three of them 18 years after operation. Two are still living 15 and 17 years after operation, and 15 have lived from 10-15 years. Ten of the 68 patients who recovered from the operation but who died later lived for more than 9 years, one for 18, one for 13, and three for 12 years. Although the causes of many of the subsequent deaths were not attributable to the disease itself, it is of interest that more than one-third were directly attributable to hemorrhage.³

Later figures (1934) from the Mayo Clinic show that of 184 cases of splenic anæmia there were 17 hospital deaths, 72 subsequent deaths, and 92 patients living.

Although the prognosis is gloomy, operation will nevertheless sometimes prove surprisingly successful, even in the most desperate cases, and where splenectomy proves to be impossible owing to the

² Howells, *Lancet*, 2:1320, 1938.

³ Pemberton, *Coll. Papers Mayo Clinic*, 23 639, 1931.

presence of numerous adhesions, ligation of the splenic artery, combined with omentopexy, may be a worth-while alternative palliative measure.

ESSENTIAL THROMBOCYTOPÆNIC PURPURA HÆMORRHAGICA

Werlhof (1735) was the first to describe purpura hæmorrhagica; Denys (1889) noticed that platelets (thrombocytes) were absent from the circulating blood in a case of purpura; Hayem (1896) showed that there was a flat-topped clot when blood was allowed to stand in a test tube; Duke (1910) demonstrated that the bleeding time was prolonged in these cases owing to a diminution in the number of platelets and also to a deficiency of fibrinogen; Hess (1916) showed the importance of the positive capillary resistance test and was the first to suggest that the spleen should be removed in this disease; and Kaznelson (1916), at Hess's suggestion, performed the first splenectomy for purpura hæmorrhagica.

There are many varieties of purpura, and Tidy (*Brit. M. J.*, 1:850, 1936) has suggested the following classification:

(A) Primary Non-Hereditary Hæmorrhagic Diathesis:

1. Purpura hæmorrhagica: (a) acute; (b) chronic.
2. Anaphylactoid purpura (including Henoch's purpura and purpura rheumatica).

(B) Symptomatic Hæmorrhagic States or Secondary Purpura.

The important causal factors under these headings are:

1. Infectious diseases.
2. Infections with pyogenic cocci.
3. Drugs, including benzol derivatives, gold preparations, and salvarsan; and
4. Sensitivity to proteins.

(C) Hæmorrhagic Deficiency Disorders.

1. Scurvy.
2. Melæna neonatorum.

(D) Hereditary Hæmorrhagic Disorders.

1. Hæmophilia.
2. Hereditary hæmorrhagic diathesis, including fibropænia and types which are intermediate with hæmophilia.
3. Hereditary capillary telangiectasia.

The only disease in this large and comprehensive group which is of any surgical importance is essential thrombocytopænic purpura hæmorrhagica. (Syn: primary purpura hæmorrhagica essential purpura hæmorrhagica, essential thrombopænia (Frank), thrombocytopænia (Eppinger), thrombocytolytic purpura (Kaznelson).

Primary purpura hæmorrhagica may be defined as an essential or idiopathic hæmorrhagic disease characterised by bleeding from the mucous membranes, petechiæ, secondary anæmia, marked reduction in the number of thrombocytes (platelets) and prolonged bleeding time. There is no reason to believe that the disease is familial, hereditary or congenital. It is three to four times commoner in females than in males, and although it occurs most frequently in childhood (between the ages of 5 and 10) and early adult life and is rare after 40, no age is exempt. In my series the oldest patient was 65 and the youngest was 5.

There are, as may be seen from Tidy's classification, many forms of purpura, but in the majority the blood changes are *secondary* in nature, as in infectious diseases, septicæmia, aplastic anæmia, hæmophilia and poisoning by certain drugs, e.g., gold preparations (Hudson; *Lancet*, 2:74, 1935), arseno-benzol (Bamforth and Elkington; *Quart. J. Med.*, 24:381, 1931), sedormid (Joekes; *Lancet*, 2:305, 1938), iodides, etc.

In primary purpura hæmorrhagica—the form under discussion—the blood changes appear to be *primary* and the disease has an unknown (idiopathic) causation. The removal of the spleen is definitely contra-indicated in the secondary or symptomatic purpuras. A painstaking clinical examination combined with a series of investigations of the blood are necessary to establish a correct diagnosis, and before making a diagnosis of idiopathic thrombocytopænic purpura, it is essential to determine that no focus of infection and no sensitivity to any drug or food substance is present.

Two forms of primary purpura hæmorrhagica are described: (a) the acute form; and (b) the chronic relapsing form.

In the *acute* form the patient suddenly begins to bleed without any previous warning and without any previous history of hæmorrhages. There is a severe uncontrollable oozing of blood from the mucous membranes and also into the subcutaneous tissues, occurring with dramatic suddenness and continuing until the patient is

bled white, becomes critically ill or dies in a few days. Hæmorrhages may also occur in the brain or spinal cord, giving rise to nervous symptoms, and Myers has described such a case in the *St. Bartholomew's Hospital Journal* (1933). There may be considerable extravasation of blood into the subcutaneous tissues, producing hæmatomata, and blood may pool over the pressure points. Petechiæ, which vary in size and colour, are always numerous and are often scattered all over the body, although they usually show a predilection for the extensor surfaces of the extremities and the anterior aspect of the trunk. They generally appear as small spots in the skin, bright red, purple or dark brown. Bleeding into the internal organs may be evidenced by hæmatemesis, melæna, hæmaturia or menorrhagia. The hæmorrhages from the buccal mucous membrane may be most distressing and even so severe as to interfere with deglutition.

In certain anomalous cases the only symptom may be severe recurrent attacks of hæmatemesis, persistent or intermittent bouts of painless hæmaturia, or intractable menorrhagia. When the disease assumes this cryptic form the diagnosis is beset with many difficulties and misgivings. An understanding of the true significance of the platelet count and other tests for primary purpura hæmorrhagica in cases of unexplained hæmorrhage, and a knowledge of the waywardness and disguises that the disease may assume will, however, prevent unnecessary examinations or rash precipitate surgical measures.

Many cases of "essential hæmaturia" or severe menorrhagia may be—and indeed are—unrecognised instances of the hæmorrhagic diathesis. It is rare for an acute case to undergo spontaneous remission and remain permanently cured. As soon as the disease is accurately diagnosed I have consistently advised splenectomy for the acute form for these reasons:

(a) *Repeated blood transfusions have, according to my experience, no effect in arresting or even in temporarily ameliorating the factors which determine a fatal issue. Numerous writers, and especially Jones and Tocantins (Tr. Ass. Am. Physicians, 51:59, 1936), state that they have found blood transfusion to be of very definite value. I have given repeated injections of whole blood or citrated blood to a number of cases, but I have not been able to convince myself that these patients have materially benefited by these means. There have been a few cases in which blood transfusion appeared to do definite harm.*

Again, unless the blood is very carefully matched, transfusions may be and often are followed by very dangerous complications such as profuse hæmoglobinuria or lysis of the donor's cells.

(b) Spontaneous recovery is never to be relied upon and must always be regarded as an exceptional phenomenon in an acutely ill patient.

(c) The patients may die from excessive loss of blood. The most effective method of producing an immediate hæmostasis in such cases is splenectomy.

(d) The mortality is not so high as is generally stated. It certainly does not exceed 10 per cent. I have operated upon 4 acute cases, of which 2 may truthfully be described as being of the fulminating type, without a death. The immediate post-operative and late results in these four cases were in every respect most gratifying and in no instance was a post-operative blood transfusion deemed necessary.

It seems to me not improbable that a number of cases classified in literature as acute essential purpura hæmorrhagica were, in fact, instances of aplastic anæmia upon which splenectomy was performed at great risk and with a high immediate mortality.

In the *chronic* form there are remissions and exacerbations, milder attacks of hæmorrhage occurring at irregular intervals. During a remission the patient may appear to be in good health, when suddenly without any warning he will be plunged into the throes of a severe attack with all the usual symptoms, such as bleeding from the gums, asthenia, pyrexia, anæmia, the appearance of bruising of the subcutaneous tissues, petechiæ, and perhaps the occasional vomiting of blood or the passing of blood-tinted urine. After a variable period of days or weeks the symptoms subside and the health begins to improve. Occasionally an intermittent hæmaturia or incoercible menorrhagia may be the legacy of an unduly severe recurrent attack.

Diagnosis. A diagnosis is made on the following points:

1. A consistently low blood platelet count. In some cases no platelets are detected in the circulating blood.
2. Spontaneous extravasation of blood into and under the skin and from the mucous membranes of the body.
3. Prolonged bleeding time.
4. Absence of clot retraction.
5. Positive capillary resistance test.
6. Marked secondary anæmia without constant changes in the red blood corpuscles.
7. No constant variation in the leucocytes, but usually an increase

rather than a decrease. 8. No evidence of any focus of infection detectable and no sensitivity to any drug or food substance.

The following are some observations on the diagnostic tests:

The Low Platelet Count. The normal platelet count varies within wide limits—200,000 to 500,000 per c.cm., the average being about 250,000. In primary purpura hæmorrhagica the platelet count is reduced to 70,000 or less, and in a severe case no platelets may be seen on successive examinations. The platelet count is always extremely low in the acute cases and during the acute exacerbations of the chronic recurrent forms (Howel Evans). It is an important diagnostic test, also indicating the severity of the condition, and is a valuable aid in deciding upon the best method of treatment to be adopted.

That the spleen may in some way destroy platelets in virtue of its content of reticulo-endothelial cells in normal health is not definitely established; but there is an accumulation of evidence that in diseases such as primary purpura hæmorrhagica it does so to a marked extent. The clinical confirmation of this destructive power was afforded in two cases of my own in which I collected samples of blood from the splenic artery and from the splenic vein prior to the removal of the spleen and had platelet counts done on each specimen. In both cases a very much smaller number of platelets was found in the specimen from the vein than in that from the artery. Myers (*Brit. M. J.*, 2:445, 1935) has fully discussed the significance of these findings.

The Prolonged Bleeding Time. The normal bleeding time is from three to four minutes. In cases of primary purpura hæmorrhagica it is increased to twenty to sixty minutes or even longer.

Failure of the Clot to Retract. Although failure of the clot to retract in a test tube is commonly stated to be a characteristic feature, I have noticed retraction to be present in but few of my cases. A flat-topped blood clot may occur in blood of perfectly healthy individuals who give no history of hæmorrhages. Too much reliance therefore cannot be placed upon this test. It is interesting to note that the blood coagulation in primary purpura hæmorrhagica is normal, in contrast to that which obtains in hæmophilia.

The Positive Capillary Resistance Test. This is performed in the following manner: Pressure midway between the systolic and diastolic is maintained for three to five minutes on the arm, either by means of a Bier rubber bandage or by a blood-pressure instrument. If

petechiæ appear between the lower end of the bandage and the wrist, the test is said to be positive. This test is usually, although not always, positive in primary purpura hæmorrhagica.

Is the spleen enlarged in primary purpura hæmorrhagica? The statement that splenomegaly occurs in a large number of cases has not been in accord with my own experience. On no occasion during numerous critical clinical examinations could I detect any splenic enlargement in 4 acute and 14 chronic cases. Again, in each of these 18 cases the spleen was carefully examined and weighed as soon as it was removed from the body. In all these cases the spleens were found to be of normal size, normal consistency and average weight. It is further stated that on microscopical examination there are special characteristic features peculiar to this disease. Again, this has not been my experience. The spleens which have been submitted to microscopical investigation have all shown a perfectly normal size and structure.

Treatment. It should be remembered that mild chronic cases may undergo spontaneous cure and this in itself is sufficient to vitiate several of the methods advocated for the treatment of this disease. Many forms of treatment have been advocated, their multiplicity of itself suggesting that none is specific. The exception is splenectomy, especially when this is undertaken in authentic cases and when at operation, after the spleen has been removed, accessory spleens or splenuli (if present) are also excised.

The following non-operative measures have been advocated:

1. Blood transfusion.
2. X-ray treatment.
3. Snake venom.
4. Ascorbic acid.
5. Internal secretions and liver extracts.

Blood Transfusion. Repeated small blood transfusions have been thought by Jones and Tocantins to hasten recovery. The usual adult dose is 300 c.cm. which is injected daily in severe cases and at intervals of four to five days in milder cases. Some surgeons give transfusions as a routine before operation in cases of primary purpura hæmorrhagica, but my experience shows that these are not only ineffective but harmful, while post-operatively they are unnecessary. Dixon (*Brit. M. J.*, 1:16, 1923) gives a favourable report of 4 cases treated

by intramuscular injections of 30 cc. of autogenous blood, but in my opinion this method has nothing to recommend it.

X-ray Treatment. The application of X-rays to the spleen has been advocated by many observers, and recently very forcefully by Mettier (*J. Am. M. Ass.*, 108:83, 1937). Most authorities, however, agree with Marzullo (*Am. J. Surg.*, 22:92, 1933) and Davidson (*Proc. Roy. Soc. Med.*, 30:715, 1937) that X-ray therapy is without effect in this disease.

Snake Venom. Peck and Rosenthal (*J. Am. M. Ass.*, 106:1783, 1936) have stated that repeated injections of snake venom are often successful and reported that of their 32 cases so treated there was symptomatic improvement in 17 cases and failure in 15. The venom is injected subcutaneously twice a week, the initial dose being 0.4 c.cm., this being gradually increased in subsequent injections up to 1 c.cm. which is regarded as a maximum dose.

Other investigators have failed to obtain any satisfactory result with venom, and the treatment is condemned as valueless by such authorities as Davidson (1937) and Lowenburg and Ginsburg (*J. Am. M. Ass.*, 106:1779, 1936).

Ascorbic Acid. Vitamin C has been extensively used during recent years in the treatment of primary purpura hæmorrhagica without any appreciable success. Szent-Györgyi (*Deutsche med. Wchnschr.*, 62:1325, 1936) isolated from lemon juice and paprika a substance which he called citrin. According to Vaughan in her splendid review (*Brit. M. J.*, 2:843, 1937) citrin is of value in preventing hæmorrhage in vascular purpura, *i.e.*, purpura occurring in patients with a normal platelet count although with decreased capillary resistance, but useless in thrombocytopenic purpura. She was able to test the citrin on one patient suffering from primary purpura hæmorrhagica; neither the platelet count nor the capillary resistance was improved, in fact the patient became so ill that transfusion was necessary. She concludes that the value of ascorbic acid in thrombocytopenia purpura is certainly open to doubt at present.

Internal Secretions and Liver Extracts. Repeated although unsatisfactory attempts have been made to utilise certain internal secretions in the control of the blood platelets. Zondek (1936) used thyrotropic hormone, Marzullo (1933) injected ovarian extracts, while many others have tried liver therapy in the treatment of this disease. Witts

(*Lancet*, 1:809, 1931), who made an extensive trial with these substances, had no success in any of the five chronic cases which were under his care.

SPLENECTOMY

None of the non-surgical measures advocated above, either singly or combined, can be relied upon to control the extensive hæmorrhages which are present in some of these cases. Splenectomy ensures a complete and spontaneous hæmostasis, as abrupt and as dramatic as that which follows the application of a ligature to a spouting artery. Visible proof of the immediate hæmostatic effect of splenectomy was afforded in two of my cases in which bleeding from the gums was so profuse as to interfere very considerably with the administration of the anæsthetic. As soon as the splenic pedicle was ligatured the hæmorrhages ceased instantaneously. This phenomenon has been attributed by some to a marked fall in the blood pressure with accompanying shock rather than to the excessive flooding of the circulation with platelets after the splenectomy. The fact remains, however, that the platelet count immediately rises by leaps and bounds after removal of the spleen, hæmorrhage ceases at once, the blood picture speedily improves, a healthy colour and tone of the body are soon regained, convalescence is rapid and uneventful, and the immediate and late results are in every respect most satisfactory.

In splenectomy for primary purpura hæmorrhagica we remove a focus of disease, possibly a parasitic organ or an organ harbouring a toxic agent. The disease is in some ways akin to hæmolytic jaundice. The spleen in hæmolytic jaundice has a vicarious appetite—an avidity for red cells; in primary purpura hæmorrhagica for platelets.

A number of cases have been recorded where even after splenectomy relapses have occurred and the disease has assumed its pristine form. Recurrence is always likely if an accessory spleen or splenuli pass unobserved or, if seen, are not removed at the original operation. Recurrence may also sometimes be traced to untreated septic foci, and removal of these foci of infection is the best prophylactic measure against recurrence.

If after a thorough eradication of all these septic foci there is a recurrence, I would advise exploratory laparotomy and a search for splenuli, and, where found, their removal. In 18 personal cases

splenculi were present in 8, i.e., in 44.4 per cent; but in each instance these were removed, this being followed by a careful scrutiny of the gastro-splenic omentum, of the great omentum, and of other likely sites for ectopic splenic remains.

Results of Splenectomy. The majority of observers are agreed that at present removal of the spleen for primary purpura hæmorrhagica gives more gratifying and permanently satisfactory results than any other line of treatment. The mortality of splenectomy for this disease has dropped from 16 per cent in 1926 to about 5 per cent at the present date. Thus Whipple (*Surg., Gynec. & Obst.*, 42:329, 1926) in reviewing 81 cases found a mortality of 16 per cent, while Quénu (*Rév. de chir.*, 67:24, 1929) in analysing 122 cases noted that the mortality was 16 per cent. Eliason and Ferguson (*Ann. Surg.*, 96:801, 1932) reviewed the results obtained in 213 reported cases; they found that the operative mortality for the whole group was 13.1 per cent, but in 113 cases collected from the subsequent four years the mortality was found to be 7.08 per cent. For acute purpura there were 35 patients treated by splenectomy with 12 deaths—34.3 per cent, but in the last 22 cases analysed by them there were only 3 deaths—13.6 per cent. In the chronic purpuras there were 160 cases with 11 deaths—7 per cent. The results obtained from the Mayo Clinic (1934) show 57 cases with 4 hospital deaths, 3 subsequent deaths, and 50 living, 42 of which are in good health.

Brown and Elliott (*J. Am. M. Ass.*, 107:1781, 1936) performed 10 splenectomies for primary purpura hæmorrhagica without a post-operative disaster.

In my series of 18 cases (4 acute and 14 chronic) there was only one operative death—5.5 per cent. There was one subsequent death, and 16 are alive and in excellent health. Two of my patients who were operated upon over thirteen years ago and three others who underwent splenectomy between ten and thirteen years ago and who have been examined annually by Myers have never at any time shown any tendency to bleed and they remain in good health, thus proving to me quite conclusively that the effects of splenectomy are permanent when the operation is undertaken with clear-cut indications.

ACHOLURIC OR HEMOLYTIC JAUNDICE

The condition may be defined as a hæmolytic disease affecting primarily the spleen and secondarily the liver, gall-bladder and bile ducts, characterised by anæmia, reticulocytosis, increased fragility of the erythrocytes, crises, acholuric jaundice and splenomegaly. There are many varieties of hæmolytic jaundice, but the only form for which surgery may be required is that which is associated with increased fragility of the red blood corpuscles.

The outstanding characteristics of the disease are by no means always constant in appearance. Lord Dawson (*Brit. M. J.*, 2:1921, 1932) has shown that in certain cases jaundice may be absent or the spleen may not be palpable, or again that the fragility of the red cells may not be constantly increased. In suspected or bizarre cases the advisability of undertaking numerous blood examinations and tests for fragility of the erythrocytes is emphasised, since removal of the spleen is contra-indicated when the red cells do not show a lessened resistance to hypotonic salt solution.

Although the disease may be acquired, it is usually congenital, and when so it is often familial. The congenital and the acquired types present many features in common, the main distinction between them being age of onset, severity of symptoms and the course of the disease.

The *congenital* form, which was originally described by Claude Wilson (1890), starts in infancy or childhood and runs a mild chronic course. The disease is hereditary and may be transmitted through healthy parents. There are few symptoms, the general health is little affected, and the lemon-tinted complexion calls for such slight comment that Chauffard (1909) regarded these patients as being more jaundiced than ill. The peaceful course of the disease is at infrequent intervals interrupted by a crisis, the signs and symptoms of which often mimic those of gall-stone obstruction of the common duct.

The *acquired* form, which is most frequently seen in adult life, is more severe in character, more sudden in onset, and more rapid and eager in its course. The crises, too, are more frequent, more prolonged and more grave than in cases of the congenital type. As the disease advances the anæmia becomes extreme, until a stage is reached when the patient is more anæmic than jaundiced.

While the prognosis is always good in the congenital form, it may be grave in the acquired. The immediate and remote results of splenectomy for the acquired cases are usually not quite so uniformly satisfactory as those for the congenital type.

Clinical Features. In a few cases, as Lord Dawson has pointed out, the spleen may not be palpable. A splenomegaly, however, of moderate proportions and occasionally of gigantic size, is usual. Although in some mild congenital cases it may take many years before the spleen obtrudes its increasing girth below the costal margin, in the more acute and active acquired type this growth is quickly and steadily progressive. In some instances the rapidity of the splenic growth is truly astounding, and within a few weeks of the onset of the disease the spleen may occupy the left half of the abdomen, reach across the midline and even obtrude into the right iliac fossa. During a crisis the spleen always enlarges and becomes painful and tender on pressure, the pain being due to rapid stretching of the capsule or to perisplenitis. The patient's complexion is pale yellow, the jaundice is mild, and this, although varying in degree, persists throughout the life of the patient. It is not accompanied by any of the usual toxic manifestations, such as intense itching, bradycardia, depression, yellow vision, etc., except, of course, in cases in which the disease is complicated by obstruction of the common bile duct with pigment gall-stones or biliary mud. Here jaundice of the obstructive type is present. Such obstruction may account for some of the signs and symptoms seen in severe crises. The fæces are normal in colour and contain bile pigment, the urine may be highly coloured—amber-brown, from the presence of urobilin but does not contain bile—hence the term “acholuric.” When, however, the common bile duct is obstructed, and this is a not infrequent complication in cases of the acquired type, bile will for a time be found in the urine and the stools will be putty-like and free from pigment. There is anæmia of the secondary type, which is slight in the mild chronic cases but becomes more marked and may be intense in the severer cases. During a crisis the anæmia becomes rapidly worse, and the erythrocytes may show a surprising fall of two or three million within a few hours. The abnormal fragility of the red cells may be an inherited characteristic. These red cells show a lessened resistance to hypotonic solution and rapidly undergo hæmolysis. Hæmoglobin is set free,

and an excess of bilirubin circulates in the blood stream and tints the skin and other tissues pale yellow. The anæmia which results is due to the excessive destruction of the fragile red blood corpuscles, but replacement with immature cells from the bone marrow may for some time and to a large extent keep pace with the destruction.

In some cases of acholuric jaundice the reticulocyte count may be very high—50 per cent or more, the normal figure being approximately only 1 per cent. Normoblasts may be present; the colour index is usually less than 1. The white blood corpuscles are usually found in normal numbers, but there may be a slight leucocytosis. In severe cases the blood picture, apart from the marked rise in the reticulocyte count, may resemble that of pernicious anæmia. Haden (*J. Lab. & Clin. M.*, 20:567, 1935) has shown that "spherocytosis" is a fundamental feature of the congenital type of acholuric jaundice.

In this disease acute exacerbations or crises frequently occur, being due either to an excessive hæmolytic destruction, *i.e.*, a form of protein shock, or to obstruction of the common bile duct with pigment stones. Such crises are characterised by pyrexia, constitutional symptoms such as malaise, anorexia, headaches, depression, etc., deepening jaundice, acute anæmia, tenderness over the spleen (which often becomes greatly and rapidly enlarged), wasting, an increase of urobilin in the urine, and a marked increase in the reticulocyte count.

Chronic cholecystitis, cholangitis, and the formation of pigment gall-stones or black biliary mud often occur in acholuric jaundice. Pemberton reported that the gall-bladder was diseased (with or without gall-stones) in 81 cases out of 118—68.6 per cent. These pigment gall-stones contain bilirubin, and occasionally there may not be even a trace of cholesterin. The bile in such cases is thick and dark coloured.

The liver may become cirrhotic late in the disease, and when this occurs the prognosis, both with regard to the mortality and the late results following splenectomy, are less hopeful.

The disease is considered by many authorities to be due to the formation in the bone marrow of immature young and unusually fragile red blood cells which readily undergo lysis. The spleen in coping with the destruction of these unduly fragile cells enlarges in proportion to the demand made upon it in the removal of these cells from the circulation. In the acquired form, however, the spleen itself

may be primarily at fault by assuming an unnaturally ravenous appetite for red blood corpuscles. In order to satisfy the peculiar demands of the spleen in this disease, the bone marrow has to work overtime, and in so doing produces a large number of defective and unduly fragile red cells for which the spleen has an even greater avidity.

Treatment. Splenectomy is the best treatment for hæmolytic jaundice of the type described, and the results are very satisfactory. Life-long jaundice disappears in a few days with marked improvement in the general health and well-being of the patient; the fragility of the red cells may occasionally show a return to normal or almost to normal after splenectomy. It is not advisable to operate during a crisis, and pre-operative blood transfusion is not recommended as it is often accompanied by hæmolysis in spite of the most careful typing. Again, blood transfusion will in some cases greatly augment the jaundice and may even lead to scanty urine and uræmia.

The mortality of splenectomy in this disease is very low, as is shown by the figures of the Mayo Clinic (1934), where 128 cases were operated upon with only 4 deaths—a mortality of 3.1 per cent. Approximately 87 per cent of the patients who recovered from the operation are living and 84 per cent of these are in good health.

Vaughan (*The Anæmias*, 1934) reported 9 cases with one death; Herfarth (1934) 176 cases with six deaths; Beckman and Jäderholm (1934) 18 cases with no primary mortality, and in my series of 12 cases there were no operative deaths.

It should be emphasised that where operation is undertaken for acholuric jaundice, the most careful examination should be made of the gall-bladder and biliary passages before the spleen is removed. Where the case is complicated by gall-stones it is better to remove the spleen in the first instance before proceeding with the surgical requirements of the biliary system. In suspected cases, however, when it is obvious that the patient is not fit to stand more than one operative procedure I would advise splenectomy in the first place in order to remove the excessive strain which is thrown upon the bone marrow, this being the most urgent need of the moment; when the patient has sufficiently recovered from the effects of the splenectomy and his general condition has improved, the abdomen should be re-opened, the gall-bladder removed, stones extracted from the common duct,

and drainage of the biliary passages instituted. If an accessory spleen or splenculi are present, they should in all cases be excised.

EGYPTIAN SPLENOMEGALY

Stiven (*Brit. J. Surg.*, 17, 1929) maintains that Egyptian splenomegaly is in some way connected with *Bilharzia mansoni*. The disease has an insidious onset and may be divided into three stages:

1. The *first* stage consists of a period of pyrexia lasting from ten to fifteen days.

2. In the *second* stage there is a gradual splenomegaly and hepatomegaly which lasts for three years or more. Cachexia, anæmia and irregular fever are prominent features, and in addition to this there are anorexia and a certain degree of pain over the enlarged spleen.

3. In the *third* stage the liver atrophies and becomes cirrhotic, and with this there is a progressive enlargement of the spleen together with ascites.

If splenectomy is not performed, death usually takes place within four years of the commencement of the disease. If the spleen is removed during the second stage or very early in the third stage, regeneration of the liver occurs and the patient's health is improved to a remarkable degree.

The blood picture before operation is fairly characteristic, and shows a marked reduction in the erythrocyte count—about two million; the white cells show a general leucopænia—about three thousand, and there is a proportional decrease in the polymorphonuclear leucocytes—about 40 per cent. There is often also a proportional increase in the mononuclear elements—40 per cent, while in some cases there may be a high eosinophil count—10-15 per cent.

Splenectomy is the only remedy for this disease. Stiven has performed over 1,000 splenectomies for Egyptian splenomegaly with a mortality of 12 per cent, while in the General Government Hospitals in Egypt from 600 to 800 spleens are removed yearly for this condition. The late results are stated to be eminently satisfactory.

RUPTURE OF THE SPLEEN

Rupture may be caused by direct or indirect violence or again it may occur spontaneously.

Direct or penetrating injuries are caused by stabs, gunshot wounds, etc., while *indirect or subcutaneous injuries* are due to falls from a height, blows or crushes.

The commonest single cause of rupture of the spleen is a fall from a height—40 per cent of cases. Motor-car accidents account for about 20 per cent of cases, and violent sports for about 15 per cent. These figures are difficult to assess correctly and are only approximate. As might be expected, the victims are usually young adult males who, by reason of their occupation or habits, are chiefly exposed to this injury.

Spontaneous rupture may occur in a normal or in a pathological spleen. While the former is exceptionally rare, the latter, although not often seen in temperate climates, is by no means infrequent in the tropics where malaria is rife. Spontaneous rupture of the pathological spleen occurs more commonly in malaria, in typhoid fever, in acute general infections, in blood disorders, during pregnancy, parturition and the puerperium, and in cases associated with splenomegaly from any cause.

In all these conditions the spontaneous rupture is probably dependent upon some slight unnoticed trauma to the softened and congested spleen. Again, the vascular endothelium of the spleen may be damaged by the circulating toxins which are present in some of these conditions. These toxins cause increased permeability and softening of the smaller radicles of the splenic blood vessels which disrupt when the intra-splenic pressure is unduly raised from any cause, leading to extravasation of the blood under the capsule of the organ. This subcapsular hematoma will by the increase of tension produce a pressure necrosis and secondary softening of the splenic pulp, and fresh blood vessels will eventually be eroded until bleeding of such a severe nature is produced that the capsule yields and bursts and the peritoneal cavity becomes flooded with blood.

A correct pre-operative diagnosis is very difficult to make in cases of spontaneous rupture. More often than not an exploratory operation is advised on account of an unexplained intra-peritoneal hæmorrhage, the cause of which is not revealed until the abdomen has been opened. The operation to be advised in all cases is splenectomy.

Susman (1927) suggests that the majority of cases of rupture in a normal spleen are, in fact, cases of traumatic rupture in which a

trivial injury has been sustained and has been forgotten by the patient. The tear in the spleen is quickly sealed off by a coagulum or by a portion of omentum so that there is little or no intra-peritoneal bleeding at the time of the original injury. After an interval of a few days or even weeks, however, the plug becomes softened and dislodged and permits of a copious and unchecked hæmorrhage.

I am in accord with this view, and hold that the spleen, owing to its marked friability, is probably the only viscus in the abdomen which is liable to laceration on receipt of some slight external injury.

Clinical Types. 1. Spontaneous rupture.

2. Where there has been a severe injury followed shortly afterward by syncope and death.

3. Where there has been an injury followed by shock, a latent period, and then signs of internal hæmorrhage.

In type 2 there has been a severe injury and the patient is admitted to hospital in a collapsed and often unconscious condition. Death frequently follows before a diagnosis can be made, and even where such a diagnosis is possible it is fruitless to attempt operation with the patient in a moribund state. In such cases the spleen is often cut adrift from its pedicles, torn in half or reduced to pulp, and the abdominal cavity filled with blood, while the presence of other injuries, *e.g.*, multiple fractures, fracture of the base of the skull, etc., will proclaim the futility of operative interference.

In type 3 the patient has sustained an injury, this being followed first by shock and then by a latent period during which there is recovery from shock. This latent period may last only a short time, sometimes less than five or six hours; but it may be prolonged for several hours or days, or even for as long as two or three weeks, before signs of internal hæmorrhage are evident. This is the type most frequently seen in surgical practice.

In cases of ruptured spleen the signs and symptoms will vary according to the severity and rapidity of the hæmorrhage, whether or not there are any concomitant injuries to other abdominal organs, and to the time which has elapsed between the receipt of the injury and the examination of the patient. In those cases in which the spleen alone is implicated, there are as a rule three definite stages, the signs and symptoms of which are fairly distinct:

1. The stage immediately following the injury. This is the initial

period of shock—a reflex sympathetic disturbance such as may be associated with any abdominal injury.

2. The latent period. This is the time during which to all appearances there is no hæmorrhage from the spleen and the patient has recovered from primary shock. This stage varies considerably in length. It may be very short—a question of a few hours at most, before signs of internal hæmorrhage become evident; it may be more protracted, even to twenty-four hours, or again there may be a lapse of as much as a week or two before there is any recurrence of the bleeding, this being known as the delayed type of ruptured spleen.

During this latent period in fully half the cases there may be no abnormal signs and symptoms to be found on examination. In some instances the patient will be apparently normal again within twenty-four hours of the receipt of the injury, while in another 30 per cent he will be discharged from hospital as fit and may even return to work for several days before the catastrophe of a severe intra-abdominal bleeding occurs. In about half the cases seen during this latent period the following points may be elicited on examination: Aching pain below the left costal margin, left shoulder pain (Kehr's sign), tenderness in the left flank, muscular guarding in this region, local tumefaction, a low degree of pyrexia, a slight icteric tinge of the conjunctivæ, and sallowness of the skin. Pain is the commonest symptom of ruptured spleen. If continuous and located at the left upper quadrant of the abdomen, it is suggestive of such an injury; pain referred to the left shoulder region as a result of irritation of the branches of the left phrenic nerve by blood clot is very often felt although enquiries as to its presence are seldom made.

3. The stage of rapid bleeding into the peritoneal cavity. During this stage the familiar signs of internal hæmorrhage may be evident. The symptoms of pallor, faintness, thirst, vertigo, tinnitus, palpitation and tremor, with cold extremities, unusual sweating and rapid pulse, are caused by a sudden anæmia.

In any suspected case of severe hæmorrhage, a hæmoglobin estimation will give a useful indication as to the degree of anæmia present, allowing time, however, for dilution of the blood from the fluid reserves of the body. If the hæmoglobin estimation falls below 50 per cent it will indicate that the patient has lost a large quantity of blood, although immediately after hæmorrhage the hæmoglobin

percentage is often normal or even increased on account of shock. In cases of severe hæmorrhage there is an abrupt and often considerable drop in the blood pressure. Signs and symptoms of internal hæmorrhage are only conclusive when bleeding has been in progress for some time. In the majority of cases the symptomatology is relatively unimportant, and on examination the most that will be found is a certain degree of pallor and sweating, some tumefaction of the abdomen and cold extremities.

The temperature, after a sharp fall, gradually rises to 99° or 100° F., while the pulse-rate is increased and mounts rapidly until eventually it becomes thready and almost imperceptible at the wrist. Respirations are increased and shallow. When air hunger is present, the respiratory count may be impossible.

At this stage the abdomen may be slightly distended, and tenderness and rigidity may be elicited in the left hypochondrium. Shifting dulness and Ballance's sign may give added confirmation to the diagnosis.

Treatment. As soon as the condition is recognised, operation should be carried out. As the diagnosis is often in doubt and multiple intra-abdominal lesions may be encountered, it is best to open the abdomen through the midline in the epigastrium. The ruptured spleen will often be found to be mobile and can usually be drawn easily through the incision. If the spleen is fixed by adhesions or has a short pedicle it should be mobilised in the manner suggested by Wilkie (page 540).

After the splenic blood vessels have been securely tied and the spleen cut away, any blood clots which are present in the peritoneal cavity should be removed and free blood aspirated or mopped up as far as possible.

A rapid exploration and examination of the other abdominal viscera is then performed in view of the possibility of further injuries, particular attention being paid to the liver, the duodeno-jejunal flexure and the upper coils of the jejunum.

The operative mortality of ruptured spleen of type 3 is said to be 10 per cent. I have operated upon 7 cases and all but one patient survived—a mortality of 14.2 per cent.

CHAPTER 3

STERNAL PUNCTURE IN THE DIAGNOSIS OF DISEASES OF THE SPLEEN

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The functions of the spleen are so intimately associated with those of the erythropoietic and myelopoietic tissues that it may be essential in the differential diagnosis of a condition of splenomegaly to obtain an idea of the state of the bone marrow, and this is most easily done by the method of sternal puncture introduced by Arinkin (*Folia hæmatol.*, 60:258, 1938).

TECHNIQUE

Various types of needles have been devised, but all have the same essential features; the one illustrated was made for the author by Messrs. John Bell and Croyden (London) and combines the type of handle recommended by Nordenson (*Studies on Bone Marrow from Sternal Puncture*, Stockholm Thesis, 1935) which enables a firm grip to be obtained and steady pressure exerted, with an easily adjustable stop, the position of which can be altered with one finger after the needle has been inserted; the diameter of needle used is usually 16 to 18 gauge (fig. 122).



FIG. 122.—STERNAL PUNCTURE NEEDLE. HALF NATURAL SIZE.

The patient is placed on his back and the skin over the front of the sternum is cleaned; the most suitable site for puncture is in the sternal body, just below the angle, on a level with the second or third intercostal space. A point slightly to one side of the midline has been recommended by Bodley-Scott (*Quart. J. Med.*, 8:127, 1939) owing to the occasional cartilaginous union of the two sternal plates. The

level of the second interspace is the site of election in infants, as the most constant centre of ossification occurs at this point (Kato, *Am. J. Dis. Child.*, 54:209, 1937).

The skin and periosteum are infiltrated with a local anæsthetic, and the point of the needle is pressed through the skin and passed down to the bone. The stop is then adjusted about 0.5 cm. above the skin level and the needle forced with a boring motion through the anterior lamina either at right angles to the sternum or in a slightly upward direction. Sometimes a distinct "give" can be felt as the needle enters the marrow cavity, but in any case by the time the stop is flush with the skin, the marrow has usually been reached. The stylet is then removed and a 1 or 2 cc. syringe inserted at the top. Slight suction is usually sufficient to withdraw some fluid, but in atrophic marrows it may be necessary to use a larger syringe in order to exert greater suction and even then not more than a drop or two may be obtained.

It is important to withdraw only a small quantity of marrow fluid, not more than 0.2 cc., as the greater the amount removed the more will be the dilution of marrow cells by peripheral blood. As the fluid flows out the patient may experience a temporary sense of constriction in the front of the chest.

The most satisfactory films are made from the fresh fluid, and this must be done at once as clotting occurs rapidly. If other examinations are required, such as a total cell count or supravital preparations, the fluid may be oxalated and preserved. The variation in the total nucleated cell count, even in normal individuals (25,000 to 100,000 per cu. mm.) (Hynes, *Lancet*, 1:1373, 1939) is so large that the figure is not of any great value, and sufficient information is usually obtained by noting the cellularity of the films. The most useful examination is undoubtedly the qualitative study of the cells present combined with a differential count on them.

Considerable difficulty has arisen in standardizing the normal count as a result of the confusion in nomenclature of the cells, and the wide limits of variation of many of the percentages in normal individuals. Bodley-Scott (*supra*) has calculated the grand mean of the normal counts given by 13 different workers up to 1939, as well as the maximal and minimal ranges; the mean figures correspond very closely with the averages obtained in his own series of normals.

Cells	Bodley-Scott, Modified to the nearest 0.5%	Mean of 13 Workers	Maximal-minimal Range
The Granular Series:			
Myeloblasts	2	2.2	0.3 - 5.1
Promyelocytes	4.5	15.2	5.2 - 21.6
Neutrophil myelocytes ..	13		
Neutrophil metamyelo- cytes (young forms)	15.5		
Neutrophil band forms . (staff cells)	16	48.8	38.1 - 66.0
Neutrophil segmented forms	15.0		
Eosinophil myelocytes .	2		
Eosinophil segmented forms	1.5	3.0	1.0 - 5.2
Basophils	0.1	0.23	0.07- 1.0
The Red Cell Series:			
Pronormoblasts	0.5	19.0	12.1 - 30.1
Basophilic normoblasts (early erythroblasts)	2		
Polychromatic normo- blasts (late erythroblasts)	12.5		
Orthochromatic normo- blasts	2.5		
Other Cells:			
Lymphocytes	11	12.8	3.5 - 24.9
Plasma cells	1		
Monocytes	1	3.31	0.25- 9.0
Reticulum cells			
Megakaryocytes			

The myeloid-erythroblast, or M:E, ratio is the proportion of cells of the granular series to nucleated red cells, and is conveniently calculated from the total percentages of each. The former are normally between 3 and 4 times as numerous as the latter, with an average ratio of about 3:5. The figure is useful in assessing which of the two systems is predominating and therefore, presumably, the most active, though Nordenson (*supra*) stresses that activity of one or other is not always manifested by a relative increase in their numbers and

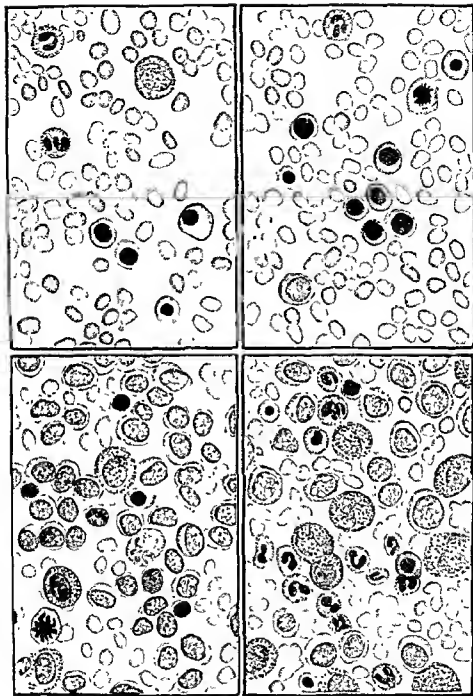


FIG. 123.—MARROW FILMS.

A, normal marrow. *B*, acholuric jaundice. *C*, acute myeloblastic leukaemia. *D*, chronic myeloid leukaemia.

may only be shown by a high proportion of mitotic figures in the younger cells of the series.

The films are stained by one of the Romanowsky stains, such as Leishman or Jenner-Giemsa, or by the May-Grunwald-Giemsa process. The identification of the commoner cells seldom presents much difficulty after a little practice, though occasionally unusual cells may have to remain temporarily unclassified. The most difficult cell to place is the "hæmatogone" which consists of a small, round, dense nucleus with an occasional thin rim of cytoplasm; the nature of this cell is a matter of controversy, some workers call it a micromyeloblast or a lymphocyte, while others consider it an undifferentiated stem cell. It has usually been included among the lymphocytes in a differential count. A typical field from a normal marrow film is shown in figure 123.

THE STERNAL MARROW IN SPLENIC DISEASES

The Leukæmias.—*Chronic Myeloid Leukæmia.* In this disease sternal puncture is seldom necessary to establish a diagnosis and marrow films show a very cellular picture, with the granular series predominating and on a slightly less mature plane than in the peripheral blood, and a high M:E ratio. Occasionally the subleukæmic or even aleukæmic cases are met, and in these the marrow picture is similar to that in leukæmic cases, so that sternal puncture will establish the diagnosis (fig. 123).

Chronic Lymphatic Leukæmia. In a fully developed case of this disease the marrow shows a high percentage of lymphocytes. Nordenson (*supra*) states that this lymphatic transformation of the marrow is never present with the peripheral lymphocytosis which may occur in various conditions, *e.g.*, pertussis, infectious mononucleosis, etc., and is diagnostic of leukæmia.

Subleukæmic and leucopenic cases of lymphatic leukæmia are not uncommon, and a lymphatic marrow will usually, though not always, be found in these cases. Kingery, Osgood and Illge (*Arch. Dermat. & Syph.*, 35:910, 1937) consider that more than 20 per cent of lymphocytes in marrow smears indicates leukæmia, but Bodley-Scott (*supra*) prefers a count of 40 per cent or more, and stresses that a normal count does not necessarily exclude the condition.

Acute Leukæmia. It is in the diagnosis and exclusion of this disease that sternal puncture has proved of the greatest value. Cases with many myeloblasts or lymphoblasts in the peripheral blood present little difficulty; but cases of acute leukæmia are frequently observed exhibiting leucopenia, thrombocytopenia and anæmia, often of a hyperchromic type, in which not a single primitive cell can be found in the peripheral blood, and diagnosis may be impossible without sternal puncture. In such cases a raised, usually very high, percentage of myeloblasts can be found in marrow films (fig. 123). Kingery *et al* (*supra*) suggest that more than 4 per cent of myeloblasts or 20 per cent of promyelocytes is sufficient to establish a diagnosis of leukæmia. Similarly, the finding of a normal or erythroblastic marrow will exclude acute leukæmia with certainty.

Lymphadenoma (Hodgkin's Disease). The sternal puncture findings in this disease have not proved to be diagnostic. Various minor changes have been described, but none of them is specific and the main use of the investigation is the exclusion of other conditions which may have to be considered in differential diagnosis.

Acholic Jaundice and Other Hæmolytic Anæmias. Especially in the acute phases, acholic jaundice provides a marrow picture which is most typical. Great activity of the erythropoietic tissue is seen, with an increase of normal nucleated red cells to between 50 per cent and 75 per cent of the differential count, with many mitoses, giving an M:E ratio of 1.0 or under (fig. 123). In chronic cases these features may not be so marked, while Vogel, Erf and Rosenthal (*Am. J. Clin. Path.*, 7:436, 1937) found a normal marrow in splenectomised cases. Other hæmolytic anæmias show a similar but less marked normoblastic marrow response.

The Lipoidoses. Sternal puncture has proved most useful in the diagnosis of these diseases, and typical cells have been found in marrow smears from Gaucher's disease by many workers. Vogel *et al* (*supra*) examined four cases, in all of which the diagnosis was established by this means.

Kato (*supra*) records a case of Niemann-Pick's disease in which large numbers of foam cells containing the typical phosphatide were found in smears from sternal puncture.

Thrombocytopenic Purpura. Numerous investigations of the marrow in this disease have failed to establish any specific changes in the

megakaryocytes. After an acute attack, with extensive hæmorrhages, considerable activity would probably be found in the erythropoietic elements.

Laurence and Knutti (*Am. J. M. Sc.*, 188:37, 1934) examined the sternal marrow from six cases and found apparent hypoplasia of the megakaryocytes in three of them. They suggest that splenectomy is more likely to be of value in those cases in which the marrow shows no sign of megakaryocyte aplasia. They did not encounter any difficulty with excessive hæmorrhage after carrying out sternal biopsy in this disease.

Tropical Diseases. Examination of the sternal marrow was originally used by Ghedini in 1908 (quoted by Nordenson, *supra*) in malaria and leishmaniasis, and in both conditions he found the parasites more common in the marrow than in the peripheral blood. Sternal puncture may be useful in chronic malaria, as the protozoa can often be found in the marrow when they are absent from the blood. In kala-azar several workers (*Lancet*, 1:37, 1939) have stressed the fact that splenic puncture is not without danger, and sternal puncture has provided the safer route to the reticulo-endothelial system in order to discover the presence of Leishman-Donovan bodies. In cases of relapsing fever Kassirsky (quoted by Bodley-Scott, *supra*) found parasites in the marrow when they were absent from the blood.

Sternal puncture may therefore be a valuable method of diagnosis in tropical infections in which splenomegaly is a feature.

Miscellaneous Diseases. In a number of other conditions in which the spleen may be enlarged, sternal puncture has been carried out, but the findings have not been typical nor of any great diagnostic value. Among these may be mentioned splenic anaemia (Banti's disease), infectious mononucleosis, undulant fever, polycythæmia vera, endocarditis lenta, etc. References to these conditions will be found in the more extensive works on sternal puncture, e.g., Nordenson, Vogel *et al*, Bodley-Scott, Hynes (all *supra*) and Young and Osgood (*Arch. Int. Med.*, 55:185, 1935). For practical considerations of the technique in infants and children, Kato (*supra*) may be consulted.

Sternal Trepanation. The method of trephining a small portion of bone from the anterior lamina of the sternum, making smears

from the exposed marrow and cutting sections after the decalcification of the bone, was used long before puncture. It has the disadvantage that it is a minor surgical procedure and cannot be repeated several times on the same patient, as can puncture. Moreover, it leaves a small scar. On the other hand, the architecture of the marrow can be studied, which is of advantage in a number of conditions. In the majority of cases sternal puncture will give all the information that is required. Dameshek, Henstell and Valentine (*Ann. Int. Med.*, 11:801, 1937) have gone fully into the value and limitations of the two methods.

GENERAL CONSIDERATIONS

It will therefore be seen that sternal puncture may be of the greatest value in the diagnosis of unexplained splenomegaly, though the marrow findings should always be considered together with the peripheral blood picture and any other investigations which may be of help in diagnosis. In some conditions, *e.g.*, aleukæmic leukaemia, the lipoidoses, tropical infections, it may provide the diagnosis where other methods have failed, while in many cases it will confirm a tentative diagnosis or exclude a number of diseases which have been considered in differential diagnosis.

PART IV

PANCREAS

CHAPTER I

ANOMALIES AND INJURIES OF THE PANCREAS

ANOMALIES

Anomalies of the pancreas, which are due in the majority of cases to developmental errors, may be divided into those of the gland itself and those of its ducts. The pancreas originates from two buds—one ventral and one dorsal—which are at first situated longitudinally in the dorsal mesogastrium, eventually fusing and coming to lie transversely as the result of the rotation of the stomach and of the development of the omental bursa. The ventral bud forms the head and neck of the pancreas, while the dorsal bud becomes the body and tail of the gland. Either bud may fail to develop, with the result that either the head or the body and tail is absent. In rare cases the anastomosis or fusion of the two buds may be incomplete, and here two individual glands, each with its separate duct entering the duodenum, will be seen. Occasionally, pancreatic tissue may surround the first and second portions of the duodenum and even extend upward to cover the right border of the gastrohepatic omentum—annular pancreas.

The occurrence of aberrant or accessory pancreatic tissue, discovered either at operation or at post-mortem examination, has been reported on various occasions since the first case was discovered by Klob in 1859. Warthin (*Physician & Surg.*, 26:337, 1904) investigated and analysed 49 cases, which led to a widespread interest being created in ectopic remnants, while Hunt and Bonesteel (*Arch. Surg.*, 38:425, 1934) studied all the cases, and these numbered 186, up to the time of the publication of their article. The most exhaustive treatise on this subject, which is replete with valuable information, is that by Branch and Gross (*Arch. Surg.*, 31:200, 1935) who recorded 200 cases including 24 of their own.

Aberrant pancreatic tissue has been found in the stomach, duodenum, jejunum, ileum, in the wall of a Meckel's diverticulum, in

the hilum of the spleen and in the splenic capsule, in the omentum, in the wall of the gall-bladder, and rarely in the retroperitoneal tissues. This ectopic tissue may persist throughout life without giving rise to any clinical symptoms or pathological changes; but occasionally it may cause pyloric or intestinal obstruction, it may ulcerate, it may produce hæmatemesis or mælena, or it may even mimic the signs and symptoms of peptic ulcer. It may undergo inflammatory changes, and when occurring in the walls of a Meckel's diverticulum it may give rise to symptoms closely simulating those of appendicitis. Rarely it may undergo cancerous transformation, in which case it is of a high order of malignancy.

According to Branch and Gross, these lesions in aberrant pancreatic tissue are of interest to those dealing with the surgery and pathology of the gastro-intestinal tract, and it is important to recognise the nature of this anomalous tissue and to appreciate that it may occur without giving rise to any important changes. It has been an unfortunate experience in several cases to mistake the tissue for a carcinomatous lesion of the stomach or intestine. The prolongation of the operation while removing benign pancreatic nodules and the danger of unnecessarily opening the intestine in these instances might have been obviated had the true nature of the ectopic pancreatic tissue been recognised at the time of the operation.

The normal anatomical arrangement of the common bile duct and the duct of Wirsung, uniting to form the ampulla of Vater, may be altered so that:

1. The duct of Wirsung joins the common bile duct some distance away from the duodenum.
2. The two ducts open separately into the duodenum.
3. The two ducts open separately at the apex of the papilla, the ampulla being absent.
4. Rarely, the common bile duct unites with the duct of Santorini.

With regard to the two pancreatic ducts, the rule is that both are present and they anastomose with one another near the neck of the gland. The duct of Santorini opens into the second portion of the duodenum, at a higher level than the duct of Wirsung, which is usually the larger of the two. Occasionally, however, the duct of Santorini may be quite separate and larger, while, in exceptional cases, the duct of Wirsung may be obliterated near its termination,

in which event the common bile duct and the duct of Santorini open by separate orifices into the duodenum.

INJURIES

The pancreas is rarely injured owing to the deep and protected position which it occupies in the abdomen and to its being sheltered by other viscera (fig. 124). When it is damaged, either from contusion or penetration, other adjacent viscera are frequently involved at the same time. The pancreas may be bruised, lacerated or torn completely across by a sudden severe force which drives the organ against the unyielding bony spine and crushes it. The patient may be run over by a motor-car, kicked in the abdomen by a horse, caught between cars, crushed by buffers, fall against the edge of a table or chair, or receive some other form of blunt trauma to the epigastrium. These are the commonest ways in which so-called subcutaneous injuries are produced.

Direct or penetrating injuries are caused by stabs, gunshot wounds, and the like, and although they may involve solely the pancreas, it is more common to find that other organs, such as the stomach, liver, spleen and intestine also are implicated. In a study of 965 cases of gunshot wounds of the abdomen, Wallace (*War Surgery of the Abdomen*, 1917) found that the pancreas was injured five times. In the war of 1914-1918 gunshot wounds of the pancreas were less frequent—or at any rate less often recognised—than injuries of any other of the abdominal organs. Successfully treated cases of gunshot injuries to the pancreas have been recorded by Gordon-Taylor (three), Richard Charles (two), Mayo-Robson (two), Lockwood, Saint, John Morley, and others. The number of cases of subcutaneous injury to the pancreas published in the literature is quite small. Von Mikulicz (*Ann. Surg.*, 38:1, 1903) collected 24 instances of such injuries which were caused by external violence. Thirteen of the patients were not operated upon, and all of these died; of eleven who were operated upon seven recovered. Here the operation consisted of exposure of the pancreas and drainage. Stuart (1921) reviewed 46 cases; Volkman (1928) reported that he had operated upon 32 cases with only one death; Venable (1932) gave his experience of six cases, five of which he was able to save by timely operative interference.

and since his publication there have been reports of a number of similar cases.

There are no classical symptoms or signs indicative of injury of the pancreas. In cases of penetrating wounds, the likely course of a bullet or dagger and the position of the wound of entrance and exit are usually the only guides. In cases of subcutaneous injury there may be bruising, hæmatoma or superficial laceration of the skin of the abdominal wall, but these, even when present, are not of themselves of special diagnostic importance.

In the initial stages the clinical picture is that of shock or collapse, while later on it is often that of severe internal hæmorrhage, peritoneal irritation, or spreading peritonitis. On recovery from the shock the patient will often complain of intense epigastric pain or of a sensation of increasing constriction in the pit of the stomach. Localised rigidity and tenderness are present, and there may be shifting dullness in the flanks owing to the presence of blood or peritoneal exudates. Nausea occurs, and vomiting is often most distressing. When there has been slight bruising or a small tear of the pancreas, the patient may complain of but few and insignificant symptoms, but weeks later a cystic swelling may develop in the epigastrium—psuedo-pancreatic cyst.

Treatment. If, after the patient has recovered from the shock of the accident, the symptoms are progressive or there is sufficient evidence to suggest injury to the pancreas or to one or other of the abdominal organs, an exploratory operation should be advised. A pre-operative diagnosis of internal hæmorrhage—a questionable torn liver, or of peritonitis—a questionable perforated viscus, is usually made.

There is a choice of three incisions: (1) vertical midline epigastric; (2) paramedian; or (3) transverse. In most instances the first of these is chosen.

When the abdominal cavity has been opened it may be evident that there is some injury to the pancreas, as fat necrosis can be made out and there may be a quantity of bloodstained fluid lying free in the abdominal cavity or shut up in the omental bursa.

The abdominal viscera should be examined *seriatim*, starting with the liver and then proceeding to the stomach and duodenum, the spleen, the duodeno-jejunal flexure, and lastly the intestines

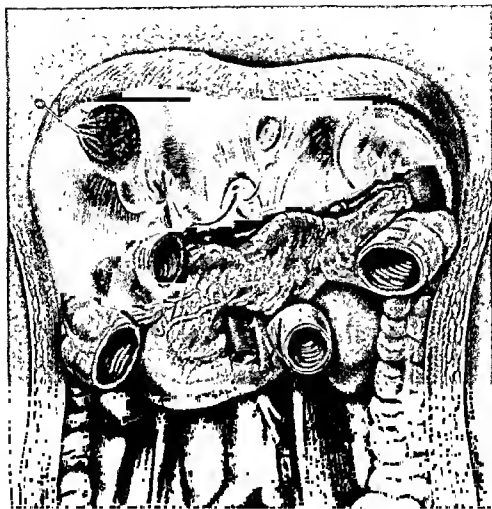


FIG. 124.—SOME OF THE MORE IMPORTANT ANATOMICAL RELATIONS OF THE PANCREAS.

If there is a large quantity of free fluid in the peritoneal cavity this should be removed by suction. The pancreas is then meticulously inspected and palpated, and in all cases in which one or more of the abdominal organs has sustained some injury the surgeon should make a practice of always scrutinising the pancreas before closing the abdominal wound; otherwise injuries of this organ may frequently be overlooked.

There are various routes for approaching the pancreas (fig. 125). These are:

1. *Through the Gastrohepatic Omentum.* In viscerotomic patients this affords the most ready access, as the central portion of the gastrohepatic omentum is very thin and diaphanous and can be widely divided without producing any bleeding. On retracting the stomach downward and the liver upward, the whole of the superior and inferior aspects of the pancreas can be visualized.

2. *Through the Gastro-Colic Omentum.* This is the route chosen by most surgeons. The gastro-colic omentum is snipped below the stomach through an avascular portion, after which the rent is widely retracted with the fingers. The stomach is then drawn upward and the transverse colon downward.

3. *By Detaching the Great Omentum from the Transverse Colon by Hey Groves's Method.* This is the method I prefer in the majority of cases, as on separating the omentum from its slender attachment to the transverse colon the whole of the lesser sac can be explored with great ease (fig 126 [3]).

4. *Through the Mesocolon.* This approach has been recommended for obese patients, but has little to commend it. The mesocolon is snipped in an avascular spot below one of the arches of the middle colic artery, and after retracting the edges of this incision

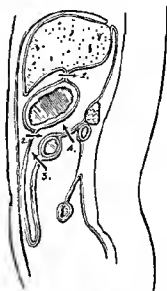


FIG. 125.—ROUTES FOR APPROACHING THE PANCREAS.

(1) Through the gastrohepatic omentum.

(2) Through the gastro-colic ligament.

(3) By detaching the great omentum from the transverse colon.

(4) Through the mesocolon.

the body and tail of the organ can be examined. It does not permit of easy inspection of the head of the gland, and there is danger of wounding the middle colic artery or one of its important branches. Again, should drainage be required, the tube will have to traverse the general peritoneal cavity, unless, of course, a fresh opening is made through the gastro-colic omentum.

5. *By Kocher's Method.* This gives a limited approach to the posterior aspect of the head of the gland.

6. *Through an Incision in the Anterior Wall of the Second Portion of the Duodenum.* Through this route the papilla of Vater or the opening of Santorini's duct into the gut can be revealed.

7. *By the Posterior Route.* This affords a very limited exposure of the tail of the pancreas. Here a left kidney incision or one which is placed just below the lower costal margin is chosen. This is the retroperitoneal route, which is sometimes used when posterior drainage is required.

After the pancreas has been displayed and the area packed off, the organ should be very carefully examined to decide upon the best method of dealing with the injury present. If there is no obvious laceration of the organ but it is greatly contused, the peritoneum over it should be incised in order to evacuate or mop up blood or clots, after which a drainage tube is led down to the site and brought out through the lower end of the abdominal incision. If a laceration is present, this should be sutured with silk. If the tail of the gland is hopelessly pulped, it is better to excise it, closing the wound in the pancreas with interrupted silk sutures. If a portion of the tail is cut adrift, here, after removing the loose portion of the gland, the tail of the pancreas is trimmed and carefully sutured. If the gland is completely torn in half, each end should be oversewn, after which the gap that remains may be plugged with iodoform gauze or merely drained with a large rubber or Penrose tube.

In all cases, from the merest contusion to the most severe rent, after dealing with the lesion by suture or packing, external drainage of the affected area must be instituted, as there is nearly always a fairly copious discharge of pancreatic fluid and peritoneal exudate following the receipt of such injuries and it is wiser that these should be led to the surface than that they should pour into the lesser sac or into the general peritoneal cavity. Again, fistula formation and

the subsequent development of a pseudo-pancreatic cyst are frequent events following injuries of the pancreas.

The abdominal wound is best closed with a series of through-and-through interrupted sutures of stout plaited silk or bronze wire.

OPERATIVE INJURIES (FIG. 126)

Operations upon the stomach, duodenum, spleen and colon may in certain instances result in injury to the pancreatic tissue, sometimes without any ill-effect but occasionally with fistula formation, acute pancreatitis or even necrosis.

It is exceedingly difficult in some cases to determine whether a hard craggy mass in the head of the pancreas is a growth or a localized patch of chronic pancreatitis, and the temptation to remove a small portion of the gland for biopsy is a very real one. It should be resisted, however, as cutting into the gland for purposes of making biopsy is sometimes followed by injury to the duct of Santorini or by the subsequent development of pancreatitis or peritonitis (fig. 126 [1]).

Pancreatitis, too, may sometimes follow transduodenal exploration of the common bile duct or the duct of Wirsung (fig. 126 [3]), and following Kocher's mobilisation a too-vigorous manipulation of the terminal portion of the common bile duct in palpating a stone or a suspected stone has been known to be followed by severe inflammatory reaction of the head of the gland (fig. 126 [7]).

Certain gastric and duodenal ulcers which deeply penetrate the pancreas and which are often associated with a marked degree of surrounding fibrosis may not be capable of excision without serious injury to the glandular tissue. It is safer in such cases to cut round the ulcer so as to leave its base intact in the pancreas rather than to cut out the ulcer from its indurated bed together with a portion of pancreatic tissue (fig. 126 [6]). Even cauterisation or the application of carbolic to the ulcer bed has been known to be followed by pancreatitis, peritonitis or fistula formation (fig. 126 [5]).

Perhaps the pancreas is most frequently injured in connection with the operation of partial gastro-duodenal resection for a chronic duodenal ulcer that has deeply pitted the pancreatic substance. Here, in removing the ulcer together with a generous portion of the first part

of the duodenum, a wedge-shaped portion of the gland may be excised with disastrous consequences (fig. 126 [4]). Again, in ligating the

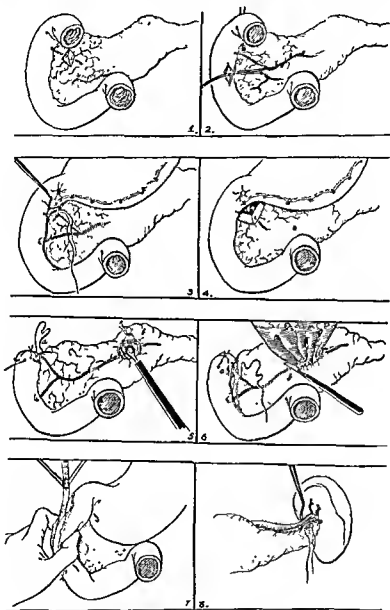


FIG. 126—OPERATIVE INJURIES OF THE PANCREAS.

pancreatico-duodenal artery a portion of the gland may be included in a ligature and this may give rise to subsequent trouble (fig. 126 [3]).

Following wide excision of the first portion of the duodenum and inversion of the stump, a suture may pick up and occlude the duct of Santorini or strangle a portion of pancreatic tissue, producing pancreatitis or localised necrosis (fig. 126 [6]).

Attempts at radical excision of a gastric carcinoma are even more possible sources of danger. In attempting to carry the dissection wide beyond a suspicious infiltrating area, it may be necessary, and it is in fact desirable, to include a portion of the gland in the resected mass. It can quite easily be understood how in doing this the main duct itself may be laid bare.

Splenectomy is another operation in which the pancreas may be injured. The tail of the gland may be clamped with hæmostats or ligatured as the pedicle is being secured, and as a result a fistula or pseudo-cyst formation may occur (fig. 126 [8]).

To mention involvement of the pancreas during the performance of nephrectomy does not appear to indicate fortunate surgery, but since instances have been quoted in the literature the possibility must be recognised.

CHAPTER 2

PANCREATITIS

From a clinical standpoint the simplest classification of pancreatitis is the following:

1. Acute pancreatitis.
2. Sub-acute pancreatitis.
3. Chronic pancreatitis.

Fitz (*Med. Rec.*, 35:197, 1889) described three types of acute pancreatitis—hæmorrhagic, gangrenous, and suppurative—based on the gross pathology of the gland. McWhorter (*Arch. Surg.*, 25:958, 1932) arranged the 64 collected cases reported by him into four types:

1. Acute or sub-acute pancreatitis, in which there was no hæmorrhage but in which the gland was enlarged, œdematous and very hard.
2. The hæmorrhagic, in which hæmorrhages were present but there was no gross gangrene or suppuration.
3. Cases with gross necrosis or gangrene but no suppuration.
4. Cases with suppuration or definite abscess formation.

McCaughan (*Surg. Clin. N. Am.*, 18:1275, 1938) points out that the chief criticism of a classification based on pathological criteria lies in the confusion resulting from the designation of the various stages of the same pathological process as separate and distinct disease entities. Moynihan (*Ann. Surg.*, 81:132, 1925) considered that the types described by Fitz were essentially the same, differing only in degree.

A classification on an ætiological basis is clinically useful, and McWhorter again has suggested the following:

(A) Infectious Origin.

1. By extension along the lymphatics.
2. By extension from the blood stream.
3. By extension along the pancreatic ducts, from the duodenum, or from the bile ducts.
4. By direct extension from infected foci.

5. Following activation of bacteria in the normal gland.
6. By bacterial permeability from adjacent diseased viscera.

(B) Non-Infectious Origin.

1. Mechanical, including stasis in the ducts.
2. Chemical and originating in activated ferments resulting from:
 - (a) bile; (b) duodenal contents; (c) degenerated duct contents; (d) autolysis.

3. Degenerative changes in the pancreas: (a) secondary benign or malignant tumours; (b) resulting from vascular degeneration or hæmorrhage; (c) toxic changes following systemic disease.

4. Trauma.

(C) A Combination of Two or More of the Above Factors.

ACUTE PANCREATITIS

What causes sudden extensive necrosis of the pancreas? Dragstedt, Haymond and Ellis offered the following explanation:

In considering the etiology of acute pancreatic necrosis, it should be kept in mind that it is by no means necessary to determine a single cause for all cases in order to satisfy the existing evidence with regard to its pathogenesis. Thus, the discovery of a case of acute pancreatitis in which the bile duct and pancreatic duct empty separately into the duodenum cannot be construed as evidence against the theory of Opie (1901), but only that it is inadequate in the particular case, which may have been due to trauma, hematogenous, lymphogenous or ductal infection, or vascular injury. On the basis of the evidence existing at present, it seems probable to us that approximately 60% of the cases of acute pancreatitis occurring in man have developed as a direct result of the passage of bile over into the pancreatic ducts. Included in this group are a majority of those in which an antecedent cholelithiasis and cholecystitis have existed. In making this statement, we realize that, according to the available statistical evidence, in only one-sixth of this number has a common channel due to obstruction at the papilla of Vater by a gall-stone been demonstrated. It is necessary, then, to believe that in the remaining five-sixths of this group a common channel has been produced either by spasm of the sphincter of Oddi, transitory stone obstruction or edema of the mucosa at the papilla. No direct evidence exists to support this belief, and it does not seem likely that it will soon appear. Perhaps the most that can be said is that its possibility has been demonstrated by Archibald (1919) in experiments on lower animals, and the inescapable fact that it is easier to produce acute pancreatic necrosis by the injection of bile into the pancreatic ducts than by any other method based on pathologic events likely to occur in man. Bile

seems to produce its effect through the local toxic and cytolytic properties of the bile salts, and its action is greatly facilitated by the proteolytic enzymes of the pancreatic juice which digest and remove the protective proteins of the blood serum. Infected bile should be more effective than sterile bile, since the bacteria or their products may activate the trypsinogen. Gall-bladder bile should be more effective than hepatic duct bile because of its greater concentration of bile salts.

Of the remaining 40% of cases in which it seems that bile has played no role, we may list the following events as etiologic factors in the necrosis. They are given in the order of their probable occurrence, as judged by clinical reports, namely: extension of infection via the lymphatics from an infected gall-bladder or neighboring viscus, trauma, hematogenous infection as in mumps, stasis of pancreatic juice plus infection (Nordmann, 1913; Eve, 1915), reflux of duodenal content into the duct of Santorini or into the duct of Wirsung rendered patent by the entrance of an *Ascaris* (von Schmieden and Sebening, 1927) or because of destruction by a carcinoma, vascular injury as a result of thrombosis or embolism, and extension from a perforated ulcer. There is evidence indicating that these and perhaps other factors as well may produce an entirely typical necrosis and, . . . irrespective of the cause of the necrosis, the nature of the toxemia and death is probably the same.¹

It has not been possible to determine the cause of death in all cases of acute pancreatitis. There are probably many attributable factors. For instance, in certain cases it may be due to nervous shock, in others to anaphylaxis, to an overwhelming toxemia or to the effects of localised or generalised infection.

The disease most commonly occurs between the ages of 40 and 50, showing its greatest incidence at about 43, although cases have been recorded at the extremes of age. The majority of cases of acute pancreatitis in childhood are due to mumps, and Farnham (*Am. J. M. Sc.*, 163:859, 1922) collected 119 cases of mumps-pancreatitis, in all but two of which the patients recovered without operation, and recently Dodds (*Lancet*, 2:989, 1935) has given a summary of 14 such cases all under the age of 14.

The sex frequency seems to be very much disputed. It is quite impossible to make any dogmatic statement on this point, since the majority of surgical text-books say that the incidence is commoner in men than in women, and this is supported by Eve (*Lancet*, 1:1, 1915) who, in analysing 295 cases, found that 63 per cent were males and 37 per cent females. Von Schmieden and Sebening (*Surg., Gynec.*

¹ Dragstedt, Haymond and Ellis, *Arch. Surg.*, 28 232, 1934.

& *Obst.*, 46:735, 1928) in a compilation of 1,510 cases found the reverse to be true. Their figures showed that 65 per cent occurred in females and only 35 per cent in males. McWhorter found the incidence to be much about the same in the two sexes in his comparatively small series of 64 cases. Obese patients are said to be more often affected.

Pathology. In some cases there is no hæmorrhage, the gland being merely enlarged, œdematous and hard, while in others the hæmorrhage so dominates the picture that the pancreas appears to be wholly engorged with altered blood. The gland is usually considerably enlarged. It may be a pale yellow colour and glassy from water œdema; it may show small or large hæmorrhagic areas; it may be black and gangrenous; it may be composed of various sized green-grey sloughs; or it may be riddled with small abscesses or be converted into a bag of pus. In the milder grades, the gland feels leathery, whereas in the more severe types it is soft, putty-like and friable. The destructive process may be limited merely to one portion of the gland, for instance the head, or on the other hand, it may involve the entire organ.

On microscopical examination the sections show that there is a marked necrosis of the acinar tissue, while in severe cases no normal pancreatic structure can be identified.

The result of the biochemical explosion depends upon the extent of the necrosis. If small areas alone are involved they may be absorbed or converted into fibrous tissue; but if large, the necrotic areas soon slough or suppurate.

Two characteristic features of acute pancreatic necrosis are: 1. The presence of sanguineous or sero-sanguineous exudate, rich in pancreatic ferments, which in mild cases may be confined to the omental bursa and to the retroperitoneal tissues in the immediate vicinity of the pancreas, and which in more severe cases floods the whole peritoneal cavity; and 2. Fat necrosis. This was first noticed by Schmidt (1818), but the first authentic description was given by Balser (1882), and since then Flexner has shown that these bright white localised nodules are due to the action of the fat-splitting ferment—lipase—which, acting on the neutral fat, splits it up into glycerine and fatty acids, the latter then combining with calcium to form an insoluble soap.

Clinical Picture. Acute pancreatic necrosis is a rare condition and accounts for about 1 per cent of all cases of acute abdominal disease. It is frequently stated that the common failure to diagnose acute pancreatitis correctly is due to not bearing in mind its possibility in the individual case, but as Cope (1932) affirms, even when the condition is thoroughly considered and discussed, a mistaken pre-operative diagnosis is often made. Even today in the best equipped hospitals and with every available ancillary method of investigation to hand, it is probably correct to state that less than half of the cases are rightly diagnosed before the abdomen has been opened. It is this difficulty and uncertainty in forming a positive opinion during the first few critical hours of the catastrophe that determine the lines that treatment should take. Moynihan was most insistent that early and correct diagnosis was possible in almost every case: "The clinical picture presented by a case of acute pancreatitis is quite unmistakable. No other catastrophe within the abdomen produces at once such unendurable agony and so profound a collapse." ² This is probably true for the fulminating type of case. The more acute the disease the more typical is the clinical picture and the more obvious the diagnosis; but the clinical severity of the condition is most variable and ranges from a state so devastated by visceral shock that operative interference is quite out of the question to a state in which symptoms are barely more severe than those seen in the early stages of acute cholecystitis.

In a general way the clinical manifestations depend upon the type and upon the extent of the pancreatic lesion. Thus, in the acute oedematous or interstitial type the signs and symptoms are subdued, whilst in the hæmorrhagic and necrotic types they are very pronounced. The difference then is largely one of degree. The symptoms in the average severe case are most dramatic. The patient may have had repeated premonitory attacks of epigastric pain which have subsided spontaneously, and in approximately one-third of the cases there is a history of sharp bouts of upper abdominal colic. Pain is the dominating feature. It arises suddenly, strikes the patient down and produces unendurable torture. It is so intensely agonising that he may cry out in anguish or faint at its first assault. It is felt most acutely in the epigastrium and in one or both loins, stabs forcibly

² Moynihan, *Abdominal Operations*, 1926.

through to the back and may radiate upward to the scapular region. The position of the gland accounts for the epigastric and loin pains, while the proximity of the solar plexus and peritoneum explains its severity. After a few hours the intensity of the pain diminishes, being replaced by a dull stubborn ache, localised to the epigastrium and to the back. The rhythmicity of the pain and the fact that it is not influenced by the administration of morphia receive special emphasis from Henderson and King (*Arch. Surg.*, 30:1049, 1935).

Profound shock speedily ensues, and sometimes synchronizes with the onset of the pain. The patient feels faint and helpless, lies motionless or writhes in bed in an attempt to seek relief by change of position. His face is pallid and beaded with sweat, and the extremities are cold and damp. The temperature at first is sub-normal, the respirations are hurried and difficult, and the pulse is racing at a great pace. Vomiting is incessant, and retching is uncontrollable and stridently noisy. It should be noted that from the onset of the acute pain the pulse-rate is very rapid (120 or more) and remains so for at least twenty-four hours. This should be contrasted with the steady normal pulse which is felt during the first few hours following perforation of a peptic ulcer of the stomach or duodenum.

The vomiting is of the true reflex type—frequent and spasmodic, with the bringing up of a few ounces at the most of opalescent mucus-laden bile-tinted gastric or duodenal contents. It is never faeculent as in true intestinal obstruction.

In some cases the face is livid or of a dusky blue colour, and the extremities are mottled with patches which have taken on a slate-blue colour. At times the whole surface of the body may be cyanotic, but in mild cases it is chiefly the face and neck which are involved in the discolouration. Cyanosis, which was first described by Halsted (*Bull. Johns Hopkins Hosp.*, 12:197, 1901) is not present in all cases of acute hæmorrhagic pancreatitis nor is it pathognomonic of this disease since it is occasionally observed in patients suffering from pneumonia, severe intoxication or protein shock.

Examination of the abdomen will show that whereas in some cases there is localised epigastric tenderness and rigidity—the so-called epigastric peritonitis of Fitz—in others there is little or no pain on palpation and the rectus muscles are not on guard. They may, in fact, be “at ease.”

In this disease, therefore, there is a combination of the dramatic symptoms of peptic ulcer perforation and of high small gut obstruction without the definite physical signs of either. It is exceptional for an epigastric tumour to be felt, especially in the fat plethoric type of patient in which this disease most frequently occurs, as the transverse colon is usually tensely distended with gas as a result of a localised ileus. At times, however, and particularly in the more tranquil cases and in some of those who have survived the overwhelming pain, the shock and the toxæmia of the first twenty-four hours, an ill-defined mass—the swollen gland—lying transversely above the umbilicus, can be identified.

Jaundice of a mild character, often amounting to little more than a pale yellow tinting of the conjunctivæ, is noticeable in about half of the cases and is attributable to acute hepatitis, acute cholangitis, or the actual compression of the common bile duct as it courses through the substance of the œdematous, inflamed and turgescient head of the pancreas.

Within two or three days of the onset of the disease, and never before this time, ecchymoses—green, yellow or purple stains in the skin—may be seen in one or both loins (Gray-Turner's sign) and more rarely in the region of the umbilicus (Cullen's sign). These are due to collections of blood and pancreatic ferments, which have been liberated from the pancreas, tracking in the retroperitoneal tissues, and when present are pathognomonic of acute pancreatitis.

In acute pancreatitis hyperglycæmia or glycosuria may be present, and the glucose tolerance test be diminished. Leucocytosis is present in most cases. The liberation of pancreatic ferments leads to an increase in the amount of the diastase in the urine. Normally there are from 10 to 20 units of diastase in the urine, whereas in cases of acute pancreatic necrosis this may be increased to 100 to 200 units or even more. The blood diastase is markedly increased, and Elman (*Arch. Surg.*, 19:943, 1929; and *Ann. Surg.*, 105:37, 1937) has done much valuable work in establishing its diagnostic importance in the acute stage. McCaughan (*Surg., Gynec. & Obst.*, 69:530, 1939) is of the opinion that the estimation of the blood diastase is the most valuable single diagnostic test known at present for acute pancreatic disease, but that the results must be properly interpreted and correlated with other clinical and laboratory data.

According to Gatewood (*Surg. Clin. N. Am.*, 17:473, 1937) the Wohlgemuth test (1908), or Somogyi's modification of it (1938), can be readily carried out in any well-established clinical laboratory. Normally, 100 cc. of blood will produce 70 to 200 mg. of sugar by this method, while in acute pancreatitis this value may reach as much as 3,000 mg.

Loewi's test or adrenalin mydriasis is sometimes positive, but while being very useful it is by no means final. A drop or two of 1 in 1,000 adrenalin hydrochloride solution is instilled into one conjunctival sac, and the procedure is repeated in five minutes. Within half an hour the pupil on the tested side only should dilate if the test is positive. Loewi's test indicates disturbance of the suprarenal glands by contiguous disease and is found occasionally in acute pancreatitis.

In the mild cases and in the recovery period in those who have suffered a severe attack, the clinical picture is in some respects similar to that of a subsiding acute cholecystitis. There is a dull chronic pain in the epigastrium and in the back, the temperature rises in the evening and falls in the morning, the patient sweats profusely, wasting soon becomes evident, vomiting occurs fitfully, the epigastrium is prominent and tympanitic in contrast to the lower half of the abdomen which is often soft and even retracted, and a tumour mass is sometimes felt on deep pressure above the umbilicus. The tumour may be a conglomerate mass of necrotic pancreatic tissue, altered blood, disintegrating fat and insoluble calcium soap, or a localised collection of serosanguineous fluid in the lesser peritoneal cavity—a pseudo-pancreatic cyst.

Diagnosis. Acute pancreatic necrosis may easily be mistaken for:

1. *Acute Perforated Peptic Ulcer.* Here the previous history of hunger pain or of treatment with alkaline drugs, the acute onset, the intense and inflexible board-like rigidity of the abdominal muscles, the exquisite tenderness on palpation, the unaltered pulse-rate—or at least a pulse which at first is steady and only mounts by degrees as peritonitis sets in—and the crescent of free gas under the diaphragm as displayed by X-ray examination, are important points in the differential diagnosis.

2. *Acute Appendicitis.* The history of the onset and the order of the symptoms are different. Although in many cases the pain and tenderness are felt in the epigastrium, after a few hours they become

more localised to the right iliac fossa. There is no profound collapse nor is the pain ever so overwhelming as in acute pancreatitis.

3. *Biliary Colic and Acute Cholecystitis.* In these conditions the pain is located to the right upper quadrant of the abdomen and radiates to the right side of the back and to the right shoulder region. There is tenderness beneath the right costal margin, Murphy's sign is present, and at times the swollen gall-bladder can be identified.

4. *Acute Intestinal Obstruction.* This may resemble acute pancreatitis owing to the sudden onset, the cramp-like pains, the distension and the frequent vomiting. In acute small-gut obstruction, vomiting is copious and projectile, and the vomited material becomes progressively more and more offensive until finally it is even faeculent. The marked collapse, the tinge of yellow in the eyes, the cyanosis, the greatly accelerated pulse-rate, the swollen epigastrium and the noisy retching all combine to suggest a diagnosis of acute pancreatitis rather than of obstruction of the intestine.

5. *Ruptured Ectopic Gestation.* Here there is collapse, blanching and rapid pulse, but the pain, which is localised to the hypogastrium, is comparatively slight and can in no respect be compared with the sudden overwhelming seizure which accompanies acute pancreatitis. Again, the abdomen in these cases is more distended below than above. There may be a history of a missed period and perhaps a little blood-stained vaginal discharge, while on bimanual examination the culpable distended fallopian tube may be detected.

Treatment. Operation should be advised in all cases in which the diagnosis is uncertain and for the majority of severe cases which are seen within the first forty-eight hours. Conservative measures are called for in moribund patients, in those who show no signs of rallying from the initial shock, in the mild cases and in those who recover quickly from the acute attack and show evidence of steady and satisfactory improvement. Most surgeons are in favour of an operative attack upon the pancreas following a short course of treatment which aims at combating shock and acute toxæmia. The patient is kept warm in bed, morphia is injected to assuage pain, and sympatol or adrenalin to raise the flagging blood pressure, while saline solution is run into a vein to stimulate diuresis and thus facilitate the excretion of soluble toxic chemicals from the blood stream. The advocates of conservative treatment—mainly Scandinavian and Central European

surgeons—are now numerous and include Mikkelsen (*Acta chir. Scand.*, 75:373, 1934), Riess (*Arch. f. klin. Chir.*, 144:325, 1927), and Wildegrass (*Chir.*, 8:597, 1936). Mikkelsen reported 39 cases of acute hæmorrhagic pancreatitis treated by non-operative measures with a mortality of 7.5 per cent. Wildegrass studied 32 cases of acute pancreatitis; four of these were operated upon during the acute phase and two died, while of the 28 cases treated medically only three died. Eliason and North found that 8 cases in which operation was deferred until the fourth to the ninth day all recovered.

The object of conservative treatment is to tide the patient over the acute phase of the disease by adopting the Ochsner plan, and later on to explore the pancreas and biliary passages of all those who are not symptom-free. If an abscess is found in the pancreas, this is drained, sloughs (when present) are removed, and if there is evidence of disease of the gall-bladder cholecystectomy and drainage of the common bile duct by means of a T-tube are performed.

Operative Treatment. The abdomen is opened through a vertical epigastric incision and as soon as the peritoneal cavity is exposed the diagnosis at once becomes evident, since there is a considerable quantity of blood-strained serum and the typical areas of fat necrosis are seen. The dilated transverse colon bulges through the wound and requires to be packed off from the operative area with gauze swabs. After aspirating the scro sanguineous fluid, the pancreas is explored and the gall-bladder and biliary passages are carefully palpated. If the swollen pancreas bulges above the lesser curvature of the stomach, it is best to approach it through an opening made in the gastro-hepatic omentum; if it appears to be lying behind the stomach it should be exposed by tearing through the gastro-colic omentum or by detaching the great omentum from the transverse colon.

In mild cases the pancreas is merely swollen, perhaps to double its normal size, and there may be here and there a reddened area indicating that the extravasated blood has implicated only a small portion of the gland. In severe cases the whole gland may be a dark phlegmon, tensely swollen and surrounded by extravasated blood. In late cases one abscess or more may be present. There may be grey or greenish-black sloughs which can be separated easily with the finger, or again there may be a cyst containing straw-coloured fluid or altered blood. At this stage, when the pancreas is exposed it is good

practice to infiltrate the splanchnic region with 50 cc. of 0.5 per cent solution of novocaine in order to diminish shock. In the severe cases the majority of surgeons advocate that the capsule of the gland, or rather the peritoneum overlying it, should be cautiously incised to drain away the pent up fluid and to give vent to any sloughs which may be present. A large drainage tube is led down to that portion of the gland which appears to be most seriously involved, and if there is much retroperitoneal effusion or evidence of spread to the flank, posterior drainage through a small kidney incision, as originally suggested by Mayo-Robson, may be advisable. The anterior tube should be brought out through the lower end of the incision so that the upper part of the wound may be adequately protected. If the inflammatory condition of the gland is mild and the gall-bladder appears to be normal, there is no object in placing a drainage tube down to the pancreas, nor do I consider it necessary to perform a cholecystostomy, although this is the practice of many surgeons. However, when the gland is very swollen and obviously necrotic, anterior drainage is advisable. If gall-stones are present these should be removed and cholecystostomy performed; but when the patient's condition is *eminently satisfactory* it is better to excise the gall-bladder, to open the common bile duct, to dilate the papilla of Vater and to complete the operation by T-tube drainage of the common bile duct. Anterior drainage will be required if the pancreas is phlegmonous, contains sloughs, or presents areas of local suppuration. If the gall-bladder is small and shrunken but the common bile duct is markedly dilated, choledochostomy should be carried out.

In the cases which have been treated by conservative measures and which subsequently come to operation, it is advisable to resect the gall-bladder, probe the common bile duct, and complete the operation by external biliary drainage.

The abdominal incision must in all cases be approximated with a series of closely applied interrupted sutures of stout silk or copper wire, and the area around the tube should be thickly smeared with some mineral oil which contains a weak solution of hydrochloric acid to diminish the activity of the pancreatic ferments.

Mortality. Brocq (*Presse méd.*, 217, Feb., 1935) estimates the mortality at between 30 per cent and 50 per cent for surgical interference, while von Schmieden and Sebening reported on compiled statistics in

1,278 cases an average mortality of 51.2 per cent for all types of pancreatitis. It is difficult to assess the true death-rate of conservative measures, as it is possible that some of the cases which were diagnosed as acute pancreatitis were in fact cases of acute cholecystitis or some other intra-abdominal lesion. Nevertheless, Mikkelsen's figures are very suggestive and it would seem likely that in the future, with improvements in the special tests that are employed to detect the presence of acute pancreatitis, more cases will be treated on purely conservative lines.

CHRONIC PANCREATITIS

There are many degrees of chronic pancreatitis, but for all practical purposes there are only two of surgical interest.

In the first, there is a moderate degree of diffuse sclerosis of the gland, associated with vague digestive disturbances suggestive of chronic disease of the gall-bladder and bile passages, while in the second, jaundice and cachexia are present and a diagnosis of cancer of the head of the pancreas is difficult to refute.

That chronic pancreatitis is frequently associated with disease of the gall-bladder and bile ducts has been amply emphasized by many observers. Judd (1921), for instance, found that of a total of 1,290 patients at the Mayo Clinic who were operated upon for cholecystitis, 347 (26.8 per cent) had associated pancreatitis. Chronic pancreatitis may occur as a concomitant disease in those who are suffering from hepatic cirrhosis, chronic nephritis, chronic alcoholism, arteriosclerosis, syphilis, tuberculosis, pancreatic calculi, pancreatic cysts, carcinoma of the pancreas, haemachromatosis, and rarely in patients with deeply penetrating gastric and duodenal ulcers. Chronic inflammation may, of course, follow acute attacks, but its actual occurrence must be rare. It is much more probable that the disease, like cirrhosis of the liver, is chronic throughout its course. Gatewood considers that as age advances so the supporting framework of the gland gradually increases in girth, sometimes rendering it difficult to distinguish between the normal increase in size and minor degrees of chronic pancreatitis.

Opie recognised two varieties—the interlobular and the interacinar. On microscopical examination varying degrees of interlobular fibro-

sis—the partial replacement of the acini by fat globules and the intact islands of Langerhans—can be made out. In the rare interacinar variety there are marked changes throughout the whole gland, and diabetes will occur as a result.

John Fraser (*Brit. J. Surg.*, 26:102, 1938) states that pancreatic disease of all types is twice as common in the male and attains its maximal incidence between the ages of 55 and 65, there being no significant difference in age incidence between the simple and the malignant conditions.

De Tarnowsky and Sarma (*Ann. Surg.*, 101:1342, 1935) analysed 30 cases of chronic pancreatitis and found that 70 per cent of these were over 60 years of age; the youngest patient was six years of age, the oldest 83. Bohm, Deaver and Opie reported that 65 per cent, 58 per cent and 66 per cent respectively of their patients with chronic pancreatic disease were males.

Symptoms and Signs. Hinton (*Ann. Surg.*, 96:441, 1932) regards the pancreas as the only intra-abdominal organ which produces symptoms of a chronic surgical nature but in which physical examination and X-ray and laboratory tests do not aid in establishing a diagnosis except by negative findings.

The first symptom of chronic pancreatitis may be a dull aching or boring pain which is felt in the epigastrium and is sometimes referred to the right or to the left costal margin, to the back or to the scapular region. At times there are sharp colicky attacks similar to gall-stone colic or even to the intense pain of angina pectoris. Hinton believes that recurrent bouts of epigastric pain following operations upon the gall-bladder and bile passages are sometimes due to an acute exacerbation of chronic pancreatitis lighted up by the trauma of operative manipulations.

Digestive disturbances are common. In the early stages there is nausea and a sensation of discomfort or fullness in the stomach after partaking of meals containing carbohydrates or fats. Later on there is considerable flatulence, and continuous disturbance is felt in the epigastrium. Vomiting may occur a few hours after food. There may be diarrhoea or constipation, the latter being more common. The motions are bulky, frothy, buttery, pale and offensive. Anorexia, loss of weight and loss of strength become more pronounced as the disease progresses, and suggest the onset of cancer. Jaundice is a late mani-

festation and is due to compression of the common bile duct by the sclerosing head of the pancreas. This is rarely so intense as in cancer of the head of the pancreas and it is exceptional for the main ducts to be so completely occluded by the spreading and strangulating effects of the scar tissue of the gland that bile disappears entirely from the stools. It is not surprising that when the patient is seen at the stage when he is jaundiced and emaciated, a diagnosis of malignant growth of the head of the pancreas is so frequently made. A moderate degree of anæmia is commonly present.

On physical examination the hardened pancreas is seldom felt, even in cachectic patients, and the distended gall-bladder is palpable in only 15 per cent of simple lesions. This implies that chronic cholecystitis is present in 85 per cent of simple lesions and is an indication of the close association between chronic pancreatitis and biliary disease.

Special Tests. In the absence of jaundice most of the special tests are valueless. A barium meal examination of the alimentary tract is useful in excluding organic disease of the stomach or duodenum. Graham's dye test may or may not confirm a suspicion of cholecystitis, while tests for pancreatic efficiency are of doubtful worth so long as sufficient secretion enters the duodenum. When jaundice is present, the van den Bergh reaction gives a direct response and is regarded as being the most reliable test, while the estimation of the blood sugar and the icterus index are also helpful. The fæces are examined for the presence of undigested protein and for excessive quantities of fat or free starch. It would appear that in carcinoma of the head of the pancreas with jaundice there is an increase in both the neutral fat and the fatty content of the stools, whereas in chronic pancreatitis with jaundice it is mainly the fatty acids which are increased.

Surgical Treatment. The pre-operative care consists of giving the patient large quantities of fluid and sugar by the mouth, intravenous infusions of normal saline solution and small repeated transfusions of whole blood.

At operation the pancreas must be very carefully examined to determine so far as possible the nature and the extent of the lesion. The organ must be visualised and methodically palpated, after which the liver, the gall-bladder and the bile ducts must likewise be investigated to ascertain if there is any evidence of concomitant disease. In

malignant disease the gland is felt to be stony hard, knobbly and infiltrating, and some adjacent lymph nodes may be enlarged and unduly indurated with metastatic growth, whereas in chronic pancreatitis it is more common to find a diffuse fibrotic condition affecting the whole organ. There is no surrounding infiltration of the tissues and the pancreas as a whole is firm and flexible.

The surgical procedure advocated in any special case depends mainly upon the condition of the patient, the presence or absence of jaundice, the nature of the pancreatic lesion, and the state of the gall-bladder. Thus:

1. When there is no jaundice, no evidence of disease of the gall-bladder, and the pancreas is enlarged and extensively fibrotic, the common bile duct should be displayed, opened and probed, and the ampulla freely dilated. The common bile duct should then be drained by a special T-tube, one limb of which reaches for a short distance upward into the hepatic duct while the other or lower limb, which is long, is directed along the common bile duct, through the papilla into the duodenum so as to exert a continuous dilatation of the ampulla and the lower reaches of that portion of the duct which traverses the head of the pancreas. External biliary drainage is then maintained for at least one month.

2. When there is no jaundice but the gall-bladder is chronically inflamed or contains gall-stones, cholecystectomy combined with choledochostomy should be undertaken.

3. When jaundice is present and the gall-bladder appears to be normal, there is a choice of two procedures:

- (a) Surface drainage—cholecystostomy; or

- (b) Internal drainage; (i) cholecysto-gastrostomy; (ii) cholecysto-duodenostomy; (iii) cholecysto-jejunostomy; (iv) choledcho-duodenostomy.

Surface drainage is recommended for the poor risk jaundiced patient with depressed renal and hepatic functions. At a later date when jaundice has disappeared and liver function is restored to normal limits a secondary operation—cholecysto-jejunostomy for preference—to deflect the bile into the intestine, can be carried out with reasonable safety. In some cases, however, internal drainage—the gall-bladder being anastomosed to a coil of the upper jejunum—is indicated as the primary and final procedure.

4. When the patient is jaundiced and the gall-bladder is so contracted and sclerosed that it cannot be used for drainage purposes, the common bile duct should be exposed and explored. If a probe or sound can be passed through the common bile duct into the duodenum, the duct should be cautiously dilated with bougies to such dimensions that it will comfortably accommodate the long lower limb of the special T-tube, the tip of which is made to pass into the intestine fully 2 inches beyond the papilla of Vater. External biliary drainage is then instituted for a period of not less than three months. If there is a return of jaundice after this time, and it becomes necessary for the patient to undergo further surgery, at a secondary operation the gall-bladder is excised and the common bile duct is divided and its proximal end implanted into the adjacent duodenum or into a coil of proximal jejunum.

If it is not possible to dilate the common bile duct where it courses through the pancreatic head, the author's T-tube should be used in draining the common bile duct. This tube should be left in situ for three to six months, after which time, if the patient's condition is satisfactory, at a second operation the common bile duct should be divided and then anastomosed to the duodenum or to a loop of proximal jejunum.

John Fraser investigated the ultimate fate of 177 persons with chronic pancreatitis who were subjected to operation, and he found that 16.3 per cent of these died within the first year, while after a period of one and ten years 63 per cent were in tolerably good health. He writes:

I find it difficult to understand why 16.3% of the operation survivals should have succumbed within a year; there appears to be no adequate reason if the original diagnosis were correct. Unfortunately there are insufficient post-mortem records to permit of an accurate answer to the question, but such information as has been available hints that the majority of so-called simple pancreatitis patients succumbing within the year were actually misjudged at the time of operation. It seems, therefore, that the error in operation diagnosis is as follows: 7% of simple cases are mistaken for malignant disease; while 16% of malignant cases are mistaken for simple disease.

Such being the survival rates, it was important to ascertain the health condition of those who survived. This is essential information, for by it the operative procedures which it is customary to adopt will be justified or condemned. Here is the record so far as I have been able to assess it;

CONDITION OF PATIENTS DURING SURVIVAL PERIOD
(SIMPLE CHRONIC PANCREATITIS)

<i>Clinical State</i>	<i>Per Cent</i>
Enjoying good health	63
Subject to dyspeptic symptoms	28
Recurrence of jaundice	4
Subsequently operated on for biliary disease	6

I feel that these are encouraging records, and when it can be claimed that 63 per cent of the patients enjoy good health with complete and permanent disappearance of jaundice our present attitude in respect of operation is vindicated.

I would like, however, to make one comment in respect of the last two groups of figures—patients who developed jaundice subsequently or who were operated on at a later date for biliary disease. You will recall that in describing the operation performed for obstructive jaundice arising in association with simple pancreatitis two types were alluded to, internal drainage or anastomosis and surface drainage. There were 141 of the former and 53 of the latter. Now, the significant point emerges that *patients who experienced recurrence of jaundice or who were operated on at a later date were almost without exception examples of the surface drainage type of operation.* It seems clear that these later complications did not arise subsequent to the anastomosis procedures. I cannot bring forward any evidence to explain the association, but it is my impression that the complication had an infective basis, which is encouraged and possibly initiated by prolonged surface drainage.*

* John Fraser, *Brit. J. Surg.*, 26 102, 1933.

CHAPTER 3

PANCREATIC CALCULI

The first account of pancreatic stones was given by de Graaf in 1667. Up to the present time some 140 cases have been placed on record. This is a grave disease and its diagnosis is notoriously difficult; but, as Brook (*Lancet*, 2:873, 1939) says, if it is recognised sufficiently early, surgical treatment in appropriate cases is eminently satisfactory, whereas failure to diagnose it usually leads to disaster; in fact the condition is one in which treatment has outstripped diagnosis. Seeger (*Radiology*, 6:126, 1928) gave a detailed account of 26 operative cases, while Bost (*Am. J. Surg.*, 29:85, 1935) reviewed and tabulated 28 surgical cases and described an interesting one of his own upon which he had operated on two occasions with complete success. He considers it likely that many cases have been overlooked at operation and also at autopsy.

The manner of formation of these stones is in all probability similar to that of biliary or salivary calculi, *i.e.*, a combination of stasis and infection. Complete obstruction of the pancreatic ducts, as shown by Opie (1910) and later by Barron (1920), leads to atrophy of the parenchyma, but the islands of Langerhans remain free from involvement. Glycosuria therefore does not develop unless severe interstitial pancreatitis is superimposed.

In appearance, pancreatic calculi in many ways resemble salivary calculi, being white, greyish-white or yellowish-white in colour, and rounded, oval or elongated like date stones. They may be single or multiple, and they vary considerably in size. The largest stone that was recorded measured $2\frac{1}{2}$ by $\frac{1}{2}$ -inch. In one case as many as 300 rounded pellets were found. The calculi may be branched, but are rarely faceted. They are chiefly composed of the phosphate and the carbonate salts of calcium and magnesium with organic material and are therefore radiopaque. The chief chemical constituent is calcium carbonate. The fact that normal pancreatic secretion contains no calcium carbonate makes it reasonable to assume that an altered

secretion—probably the result of infection—precedes the stone formation.

DIAGNOSIS

The signs and symptoms produced by pancreatic stones are similar to those which result from a combination of pancreatitis and cholelithiasis. Pain is a characteristic feature, being dull and continuous, intermittent, or sharp and cramp-like as in biliary colic. It is felt principally in the epigastrium and back, but may radiate beneath the left costal margin. Digestive disturbances are common, while jaundice, loss of weight and diarrhoea have been observed. The faeces are usually normal in appearance, although fatty stools were noticed in three of the 28 cases which were operated upon. Glycosuria is a rare phenomenon and was noted in only one case which was subjected to operation.

Gall-stones and calcified abdominal glands are the conditions most frequently confused with pancreatic calculi. As pancreatic stones are radio-positive, containing as they do large amounts of calcium carbonate, it is obvious that X-ray examination of the epigastric region is of the greatest diagnostic value (fig. 127). In addition therefore to taking a straight or flat plate of the epigastrium it will be necessary to check up the true position of the shadows by performing Graham's gall-bladder dye test and a pyelogram.

In the successful case reported by Lindsay (*Lancet*, 2:612, 1922) the shadows were shown to be lying behind the stomach in lateral views, and by means of roentgenograms he was able to make a correct pre-operative diagnosis.

OPERATIVE TREATMENT

Caparelli (1876) reported the first successful case treated by surgical attack. His patient lived for many years and eventually died from diabetes. Pearce Gould (*Lancet*, 2:1632, 1898) is accredited by Moynihan with being the first surgeon to operate on a case of pancreatic stones; but in actual fact he was the third, as reference to Seeger's and Bost's tabulations will readily show. Pearce Gould's patient died twelve days after operation. Moynihan (*Lancet*, 2:355, 1902) recorded the fifth case. He removed a solitary stone from the terminal



FIG. 127.—PANCREATIC CALCULUS.

The stone can be seen just below the inferior border of the duodenal cap. Operation was undertaken, the stone was removed and the patient made a good recovery (Graham Hodgson).

portion of Wirsung's duct by transduodenal choledochotomy, and his patient made an uninterrupted recovery.

The operative mortality of all the reported cases is surprisingly low—7 per cent.

Two methods are commonly employed by which calculi lying in the ducts of the gland may be reached:

1. By direct incision of the pancreas over the stone, followed by suture of the wound: (a) by the anterior route, or (b) by Kocher's posterior route:

2. By transduodenal choledochotomy.

The choice of approach frequently depends upon the position of the stone or stones. Thus the anterior route is chosen when the calculi are situated in the body of the gland, and Kocher's method when the stone lies in the uppermost portion of the head of the pancreas in close proximity to the duodenum, while for stones lying anywhere near the ampulla of Vater the most direct access can be achieved by opening the duodenum and slitting up the papilla.

When the *anterior* route is employed, the gland is reached by incising the gastroliepanic omentum and by retracting the stomach downward and to the left or by detaching the great omentum from the transverse colon and drawing the stomach firmly upward. The gland being exposed and the stone located, the operative field is packed off in the usual manner to limit contamination. The peritoneum of the posterior wall of the lesser sac is divided and its margins are clipped with hæmostats to afford good retraction, and the pancreas is incised directly over the calculus, any bleeding vessel being clipped and tied. The stone is removed with Desjardins forceps. The pent up pancreatic secretions which must be assumed to be infected are rapidly aspirated and the operative field is kept as dry as possible by frequent moppings with small pellets of gauze attached to the tips of artery forceps.

Having extracted the stone, a search is made for other calculi by probing the ducts and by palpating the gland carefully. It is said that a peculiar fine crepitus, not unlike the crepitus of tenosynovitis, exists when there are multiple stones in the gland.

The incision in the pancreas and the duct is then carefully closed with interrupted sutures of fine silk, and after hæmostasis has been ensured the edges of the overlying peritoneum are approximated

with sutures of the same material. A Penrose tube is led down to the wound in the pancreas and drawn out through the lower part of the abdominal incision.

Access to the *posterior* surface of the gland is obtained by mobilising the duodenum by Kocher's method. An incision is made through a comparatively bloodless area in the peritoneum on the lateral side of the descending portion of the duodenum, and the gut together with the pancreas is lifted away from the posterior abdominal wall and turned over to the left, as it were on a hinge. The posterior aspect of the gland is then palpated with the finger to detect any hardened or fluctuating area which would indicate the position of the stone.

The pancreas is incised, the stone extracted, the wound is sutured with silk, and a drain is placed in position to provide for any leakage.

The *transduodenal* route is chosen when the calculus lies near the termination of the main duct. Here a longitudinal incision, 1 to 1½ inches long, is made through the anterior wall of the second portion of the duodenum, and the margins of the gap are held widely apart with Allis forceps to afford an uninterrupted view of the papilla of Vater. The papilla is then incised and a slender pair of Desjardins forceps is gently placed into the duct to seize the stone and extract it. A small scoop is then introduced to dilate the duct even further and to withdraw any pancreatic gravel or mud which may be present.

The incision through the papilla is left gaping and the opening in the duodenum closed transversely with three tiers of sutures.

CHAPTER 4

PANCREATIC CYSTS AND FISTULÆ

PANCREATIC CYSTS

Pancreatic cysts are rare pathological entities, and afford great interest to the surgeon from the diagnostic point of view since they appear in almost any part of the abdomen. They may be classified as follows:

1. **True Pancreatic Cysts:** (*a*) retention cysts; (*b*) degeneration cysts; (*c*) congenital cystic disease of the pancreas; (*d*) lymphatic and hæmorrhagic cysts; (*e*) dermoid cysts; (*f*) hydatid cysts.

2. **False Pancreatic Cysts or Pseudo-Cysts.**

True pancreatic cysts arise in the gland substance. Retention cysts are said to be caused by any condition which obstructs the ducts, such as stone, tumours, or chronic sclerosing pancreatitis. Degeneration cysts may arise in an adenoma or in a cancer, and up to date less than 30 cases of benign tumour have been recorded. The cyst is usually multilocular, contains clear, blood-stained or mucoid fluid. On naked eye examination they closely resemble the cystadenomata of the thyroid or ovary. They are most frequently found in the head of the gland. Congenital cystic disease of the pancreas resembles the corresponding condition noted in the kidneys. Hæmorrhagic and lymphatic cysts have been noted after injury to the pancreas, while the observation of dermoid and hydatid cysts have on rare occasions been recorded.

A false cyst is due to the incapsulation of extravasated fluid in the peri-pancreatic cellular tissues or in the lesser sac. The majority of cases are due to injury and follow a severe blow on the epigastrium which causes laceration of the posterior peritoneal layer of the lesser sac and of the pancreas. The pancreatic secretions and blood escape into the omental bursa or into the tissues around the pancreas, the foramen of Winslow becomes blocked by inflammatory exudates, and the peritoneum becomes thickened around the effusion, incapsula-

tion thus being produced. Another well-known cause of pseudo-cysts is acute or sub-acute pancreatitis.

The swelling may form within a few days or it may be weeks or even months before a noticeable tumour appears. Pseudo-pancreatic cysts vary considerably in size. They may be small, measuring not more than 2 inches in diameter, or they may be as large as a football. The wall may be thin or thick, its lining may be smooth, and septa may be present. The fluid contained in this cyst is alkaline in reaction, of medium or low specific gravity, and when analysed is found to contain albumen, mucin, cholesterin, blood cells and a little necrotic tissue. It may be clear or may be light brown or pale green in colour. One or more ferments may be present, but in long standing cysts ferments are not found or, if present, they are inert.

False cysts are most frequently found in the vicinity of the body or tail of the gland and nearly all of them lie behind the posterior layer of the peritoneum forming the omental bursa. The final position they occupy within the abdomen and the anatomical relations of the cysts are determined by their relation to the peritoneal reflections which form the lesser sac. Thus, a cyst may bulge between the stomach and liver, protrude between the transverse colon and the stomach, or appear below the transverse colon. At times it will merely push the stomach forward, or again it may insinuate itself into the root of the mesentery of the small intestine.

Symptoms. While the cyst is slowly expanding, the symptoms are vague. There is usually a sensation of *fullness after meals*, a dull ache may be felt above the umbilicus, while flatulence, dyspepsia and vomiting are commonly noted. Later on, the expanded cyst may compress the bile duct and lead to jaundice. Glycosuria and diabetes and the loss of weight and of strength are frequent symptoms. Eventually a rounded or oval tumour is felt in the epigastrium, either in the midline or toward the left side, although sometimes it may lie lower than this below the umbilicus or even in the pelvis, while rarely, when of huge proportions, it may occupy the major portion of the abdominal cavity and grossly distend it. Fluctuation may be elicited, but if the cyst is very tense it may feel like a solid tumour. In the majority of cases the cystic tumour does not move on respiration, although there may be some lateral or vertical movement on palpation.

A diagnosis is often reached following X-ray examinations of the stomach, colon, gall-bladder and kidneys. Pseudo-pancreatic cysts may be confused with ovarian cysts, cysts of the liver, mucocele of the gall-bladder, hydronephrosis, mesenteric cysts, omental cysts, cysts in the posterior wall of the stomach, cysts of the spleen, and retroperitoneal cysts and sarcomata.

Treatment. The choice of operation depends upon the size, the situation, the type and the condition of the cyst. All surgeons are agreed that the ideal treatment is excision of the cyst, but this is only feasible in the minority of cases. Of the true pancreatic cysts probably the cystadenomata lend themselves most readily to excision. James (*Brit. J. Surg.*, 23:92, 1936) has given a good account of the technique employed in two cases reported by him.

False cysts can rarely be removed intact. A few of them, when small and when not unduly adherent, and more especially when they are situated in the tail of the gland, may be extirpated; but in the majority marsupialisation is the operation of choice. Access to the cyst is obtained through a vertical epigastric incision or through an incision which is made over the most prominent portion of the tumour. When the abdomen is opened it will at once be obvious whether the cyst should be approached through an incision in the gastrohepatic omentum or through the gastro-colic ligament, or whether in those cases where the cyst bulges prominently into one flank it will not be wiser to close the abdominal incision and drain the cyst retroperitoneally through a kidney incision. By the anterior route the most prominent portion of the dome of the cyst is brought clearly into view, and after the abdominal incision and the area around have been packed off to prevent soiling, two pairs of Allis forceps grasp the cyst wall and steady it to allow a Mayo trocar and cannula to be plunged into the cavity. The trocar is partly withdrawn and the cannula connected to a suction apparatus so that the contents of the cyst can be quickly evacuated with the minimum amount of leakage. The puncture hole made by the trocar is next enlarged with scissors for an inch or so, the margins of the cyst wall are picked up with a number of Allis forceps in order to elevate the cyst, and gauze swabs are introduced into the cavity to mop up any remaining fluid and to remove any necrotic tissue. Finally the lining of the cyst is gently sponged down with sclerosing solution, such as

quinine-urethane or lithocaine, to promote fibrosis and to bring about a slow obliteration of the cavity.

The margins of the cyst wall are then stitched to the edges of the incision, after which the abdominal wound is closed snugly around the projecting portion of the cyst wall. A rubber tube is led down into the depths of the cyst and anchored to the skin to prevent it from being accidentally withdrawn.

The operation is completed by taking careful measures to prevent the incision from being irritated or contaminated by any escaping contents from the cyst.

In most cases the fistula soon closes, but if it proves stubborn, continuous suction must be employed. If the fistula cannot be induced to heal by non-operative measures and the patient is steadily losing weight, then the fistulous tract should at a secondary operation be isolated, trimmed, and implanted into a loop of proximal jejunum. In those cases where the cyst is small or flattened so that it is quite impossible to draw it to the level of the abdominal incision, a rubber tube should be inserted through an opening made by a trocar and cannula, and after stitching it to the margins of the cyst wall it should be invaginated with two or three purse-string sutures, as in Stamm's gastrostomy. The omentum is wrapped around the tube, which is drawn through the lower end of the abdominal incision. Continuous suction is employed and in the majority of cases healing is not long delayed.

PANCREATIC FISTULÆ

The majority of pancreatic fistulæ result from the draining of pseudo-pancreatic cysts. Desvauz de Lyf, quoted by Lahey and Lium (1937), found in his collected series of 113 cases of pancreatic fistulæ that 80 per cent originated as cysts which were drained, while in Lahey's collected cases (1937) of transplanted fistulæ 12 (or 50 per cent) originated as cysts and 5 followed gastric resection.

A pancreatic fistula may occur after: (1) drainage of the lesser peritoneal sac in cases of acute pancreatic necrosis; (2) penetrating epigastric wounds which involve the pancreas; (3) removal of stone or stones from the pancreatic duct; (4) excision of a pancreatic cyst; (5) gastric operations, and more especially where an ulcerating lesion of the stomach is embedded in the pancreas and partial gastrectomy

is deemed advisable; (6) splenectomy; (7) operations upon the pancreas for simple or malignant tumours or for hyperinsulinism.

The generally accepted treatment for false pancreatic cysts is marsupialisation and drainage, as originally recommended by Gussenbauer. Thus, in Judd's series (*Arch. Surg.*, 22:838, 1931) of 47 cases, 33 were treated by marsupialisation and drainage and 3 cysts were completely excised. But while this is so, it should nevertheless be mentioned that in the 9 recorded cases of primary anastomosis between a pancreatic cyst and a portion of the intestine there was no post-operative fatality and the late results were very good. Primary anastomosis of the cyst to a loop of proximal jejunum is a safe and excellent procedure, and when practicable should be carried out in preference to external drainage. Complete excision of the cyst is a hazardous undertaking and is frequently followed by leakage and fistula formation. The death-rate from extirpation of a pancreatic cyst varies between 10 per cent and 25 per cent if the cyst is removed completely, but it may be as high as 55 per cent if excision is attempted and fails.

Local Treatment.—1. *Protection of the Skin.* The principal fear that arises from the presence of a pancreatic fistula is that the skin and superficial tissues will slowly become digested, will be excoriated and inflamed and that the abdominal wall will gape and finally disrupt. With care and skilful handling in the early stages, however, the extreme pain of a self-digested abdominal wall, the raw skin, and the anguish associated with the numerous applications and constant change of dressings can largely be avoided by adopting the following measures: A rubber tube fitting closely into the fistulous tract should be led into a bottle which is attached to the abdominal dressings or to the side of the bed to drain away the secretions, or be connected with constant water suction or a McKesson noiseless suction motor. The pancreatic secretion should be preserved for measurement and also for re-introduction by mouth. The skin for 4 inches or so around the fistula is smeared with durofix or mastisol, and a wide piece of thin sheet rubber is made to adhere over this area in order to protect the surrounding skin. Vaseline, zinc and castor oil paste, kaolin, or bronze powder is packed thickly around the tube and on to any part of the skin to which leaking juices can obtain access. Potter (*J. Am. M. Ass.*, 92:359, 1929) recommended the use of beef juice

extract and one-tenth normal hydrochloric acid in the form of a local application on which the ferments might expend themselves before reaching the skin. This is a most effective measure for preventing digestion of the layers of the abdominal wall and of neutralising the alkalinity of the secretion. It is important to see that the rubber drainage tube fits the fistulous opening tightly, and as the tract dilates a larger tube should be substituted.

2. *Measures for Lessening the Secretion.* The following measures are of questionable value: Large doses of atropin (Hartmann), radiotherapy (Cullier, van Redwitz and Hamilton), retrograde injection of the tract with olive oil (Claude Bernard), or with sclerosing media, and the application of caustic agents such as zinc sulphate or of the electric cautery to the opening to facilitate its closure (Kleinschmidt). The Wohlgemuth régime (*Berl. klin. Wchnschr.*, 44:47, 1907), which consists of keeping the patient on a very low carbohydrate diet and of supplying an adequate amount of calories with proteins and fats, and of giving sodium bicarbonate in 4 gm. doses half an hour before and after meals, and ereptone (Kroiss, 1912) by mouth and rectum is worthy of a trial in most cases. If the fistula does not close completely within six weeks—it should be noted that the majority of pancreatic fistulæ tend to heal spontaneously—operation should be advised.

Operative Treatment—Pancreatico-Jejunostomy. The operation of choice is transplantation of the fistula into the jejunum—pancreatico-jejunostomy. That this is a safe and successful procedure is borne out by a number of cases. Lahey (*Surg., Gynec. & Obst.*, 64:78, 1937) found in the literature 25 cases of anastomosis between the gastrointestinal tract and a pancreatic fistula. Of these, 14 were performed as pancreatigo-gastrostomy, 9 as pancreatigo-jejunostomy, 1 as pancreatigo-cholecystostomy, and 1 as pancreatigo-cholecystostomy followed by cholecysto-gastrostomy. There was only 1 death in this series, i.e., Holbaum's case (*Zentralbl. f. Chir.*, 54:1436, 1927). In all of the other cases the immediate and late results were in every respect most gratifying. Adding Lahey's case to this number of successful operations makes a total of 26 with a mortality of 3.8 per cent, thus establishing anastomosis of a pancreatic fistula to the stomach or preferably to the small intestine as a relatively safe surgical undertaking.

By *Lahey's technique* the fistulous tract is gently plugged with gauze and coned out from the abdominal wall. The abdominal incision is then enlarged above and below the coned out area to afford free access to the stomach, pancreas and structures in the immediate

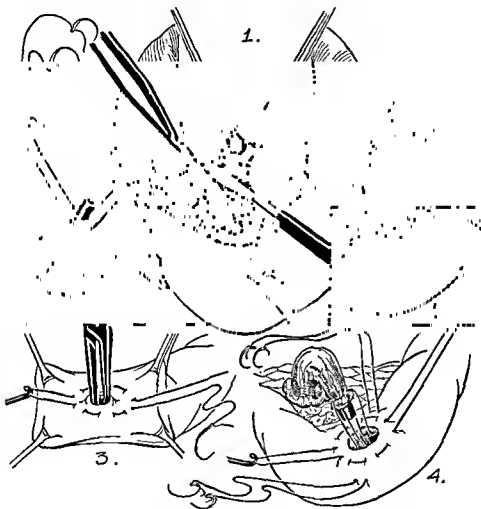


FIG. 128—PANCREATICO-JEJUNOSTOMY BY LAHEY'S TECHNIQUE.

vicinity. The distal end of the fistulous tract is seized with Allis forceps to keep it taut while it is pared down to its base in the pancreatic substance (fig. 128 [1]). In paring the tract great pains must be taken not to buttonhole it or to make it too thin, as in this case it would be useless for implantation into the intestine.

A rubber tube, which fits the tract snugly, is next inserted right down to the pancreas and tied into position near the distal end of the tract with a stout silk ligature (fig. 128 [2]). The tract is prepared in this manner before an opening is made in the jejunum for its reception. A loop of the proximal jejunum is now brought over the transverse colon and laid by the side of the fistulous tract in such a way that there is no kinking or traction of the proximal loop. The selected portion of the jejunum is now lifted up with four pairs of Allis forceps, as depicted in figure 128 (3). At a selected point exactly opposite the anti-mesenteric border a purse-string suture is inserted and in the centre of this a small hole is made with mosquito forceps. As the Allis forceps exert upward traction and steady the gut, the forceps are thrust through the wall of the intestine and the blades are gently separated to make an opening of sufficient size to accommodate the fistulous tract. Two silk sutures which are threaded on intestinal needles are passed near the end of the fistulous tract. These help to guide or lead the tract into the jejunum, and when it is ascertained that the tract is lying comfortably in the lumen of the gut, the purse-string suture is drawn tight and tied while the guide sutures are immediately removed (fig. 128 [4]). The tightening of the purse-string suture cannot occlude the lumen of the fistulous tract owing to the presence of the retained rubber tube.

The jejunum is then anchored to the base of the fistulous tract above and below and to the tissues around, not only to fix it into position and to prevent it from being drawn away from the fistulous tract, but also to avoid any angulation of the gut where it is sutured (fig. 128 [5]). Portions of adjacent omentum are drawn over the operative site and the abdomen is closed in the usual manner. After a variable time the tube in the fistulous tract works loose and is passed per anum.

CHAPTER 5

PANCREATIC TUMOURS

CARCINOMA OF THE PANCREAS

This is the most important and the commonest primary new growth of the pancreas, and constitutes 1 to 2 per cent of all carcinomata.

Primary growths are of the spheroidal-celled pattern when they arise from the acini; they are columnar-celled carcinomata when they originate from the ducts. When malignant changes affect the islets of Langerhans, the cells are peculiarly large and possess an out-size in nuclei.

Secondary growths of the gland are common because cancer of the stomach is common and because the pancreas forms the greater portion of the bed of the stomach. It is sometimes difficult with advanced growths of the pancreas or stomach to determine whether the primary growth originated in the stomach or in the pancreas.

Carcinoma of the pancreas is twice as common in the male as it is in the female, and the peak age incidence is between 55 and 65.

Sarcoma of the gland is rarely encountered as a primary disease. It may be of the round- or spindle-celled variety, and in most instances it is clinically indistinguishable from carcinoma.

Symptoms and Signs. The symptoms and signs of pancreatic carcinoma vary according to the situation of the growth. When the *body or tail* is involved, the clinical picture is in many ways similar to that of carcinoma of the body of the stomach, there being, for instance, anorexia and progressive loss of weight and of strength. The fatigue syndrome, too, is marked, and the patient feels weary, disinterested and melancholic. It is rare for a tumour to be felt in the epigastrium, even in very thin patients.

Following radiological and chemical investigations, which often throw but little light on the diagnosis, an exploratory laparotomy is advisable in order to determine the true nature of the condition.

In cases of *cancer of the head of the pancreas*, nausea, anorexia, loss of weight, and cachexia nearly always precede the onset of the jaundice. Pain, which is described as dull or aching in character and which is felt in the epigastrium and beneath the scapulae, is present in over 70 per cent of the cases and may arise either before or after the jaundice appears. At times it is intense and persistent, being made even worse by the administration of morphia, while at other times it may be intermittent and cramp-like as in gall-stone colic. The jaundice comes on insidiously; at first it is only slight, but as the disease progresses it becomes very severe and remains so until the end. The skin may be coloured a light canary yellow, olive green, light brown or even a dark mahogany hue. Very marked and intractable jaundice, associated with a maddening torture of itching which is unresponsive to local applications, is often a sign of malignant disease. A distended and tense gall-bladder is noted in nearly 90 per cent of malignant cases. This is in accord with Courvoisier's law which states that if in a jaundiced patient the gall-bladder is enlarged the condition is not one of stone impaction of the common bile duct, as previous cholecystitis will have rendered the gall-bladder fibrotic and incapable of dilatation. Moynihan (*Edinb. M. J.*, 19:410, 1906) pointed out that Courvoisier's law, like all other laws, is capable in infraction. He showed that the law may be violated in the following circumstances:

1. When there is a stone in or stricture of the cystic duct causing empyema together with impaction of a calculus in the common bile duct.
2. Where there is a calculus in the cystic duct compressing the common bile duct.
3. Where there is distension of the gall-bladder by an acute inflammatory process with blockage of the common bile duct by stone.
4. Where there is chronic induration of the head of the pancreas with a stone in the common bile duct.
5. Where there is cancer of the common bile duct or cancer of the head of the pancreas associated with chronic cholecystitis.

The liver gradually enlarges and in a well-established case can easily be palpated below the costal margin. I have known it extend to the iliac crest and to occupy at least the upper half of the abdomen. As the gall-bladder enlarges it distends downward and inward toward

the umbilicus or even below it, and at times it may be felt in the hypogastrium or right iliac fossa.

Methods of Investigation. The chronic course of the disease, which is usually apyrexial, the previous history of nausea, anorexia and loss of weight, the swollen gall-bladder, the enlarged liver, the presence of jaundice of a severe character, the incessant itching, the emaciation, the presence of bile in the urine, and its absence in the putty-like faeces, are factors which of themselves suggest a provisional diagnosis of cancer of the head of the pancreas or of the lower reaches of the common bile duct. The disease is most often confused with so-called catarrhal jaundice, chronic pancreatitis, or calculous obstruction of the bile passages. Every effort should be made to arrive at a diagnosis as soon as possible, as the longer the obstruction persists the greater the damage inflicted on such vital organs as the liver and kidneys and the greater the risks of operative interference. The following investigations should be carried out in every instance:

1. *A Barium Meal Examination.* This is advisable in order to rule out the possibility of cancer of the stomach and to throw some light on the condition of the duodenum. The suggestive signs of duodenal involvement are fixation, distortion, dilatation, marked narrowing, and widening of the duodenal loop.

2. *Gall-Bladder Dye Test.* In certain mild cases this may be of value, but where jaundice is pronounced it is useless and even dangerous.

3. *The Van den Bergh Reaction.* This test is employed to confirm the obstructive nature of the jaundice.

(a) A *direct* reaction proves the existence of a mechanical blockage.

(b) A *delayed direct* reaction is indicative of impaired liver function.

(c) A *biphasic* reaction is said to indicate that there is a combination of obstruction and impairment of liver function. In my opinion a biphasic reaction has no particular significance but an immediate direct Van den Bergh reaction is an infallible proof of the obstructive nature of the jaundice.

4. *Icteric Index and Serum Bilirubin Readings.* These are undertaken to estimate the degree of obstruction. These tests should be carried out daily or even twice a day, since, according to John Fraser (*Brit. J. Surg.*, 26:102, 1938) they afford under such circumstances

an accurate estimate of the degree of obstruction. Furthermore, if they show a rapid and progressive rise in intensity these findings imply approaching liver failure and consequently an increased anxiety in respect of prognosis. In obstructive jaundice the icteric index figures may range from 18 to 270, and any reading above 150 is ominous. Under normal conditions the serum bilirubin readings range from 0.1 to 0.5 mgm. per cent, any figure in excess of 5 mgm. per cent being associated with definitely increased risks.

6. *Fat Content of the Stools.* It is possible that an examination of the stools to determine the fat content may prove of value in indicating the site and the nature of the pancreatic lesion. In cases of growth, for instance, both the neutral fat content and the fatty acids of the stools are increased, while in chronic pancreatitis the increase is mainly in the fatty acids.

7. *Sugar Tolerance and Blood Urea Tests.* These are carried out to estimate the effect of the obstruction on the vital functions. The first test is employed to determine the efficiency of liver function, while the second is to estimate the amount of damage which has been done to the kidneys. Although it is generally admitted that the sugar tolerance test is a fairly reliable index of the state of liver function, if the findings are to be depended upon, blood sugar estimates rather than urine estimations must be taken, since the latter are not sufficiently constant. The blood urea is raised in cases of obstructive jaundice, and the higher the reading the graver the prognosis.

8. *Duodenal Drainage.* The absence of bile in the aspirated fluid is a significant finding.

Pre-Operative Treatment. The majority of these patients are in poor condition when they are referred to the surgeon for treatment. They are jaundiced, anæmic, emaciated, dehydrated and toxic in the extreme. They often respond satisfactorily to a few days' intensive treatment which includes the giving of large quantities of glucose by mouth, intravenous infusions of salt and sugar, and repeated transfusions of whole blood. Calcium gluconate, 10 cc. of a 10 per cent solution, is given twice daily for three or four days, while a diet rich in vitamins is also prescribed.

The liver plays an important role in vitamin synthesis and storage. According to McNealy (*Tr. Internat. Coll. Surg.*, 1:132, 1938), in a

jaundiced patient the liver may be damaged so that absorption, synthesis and storage of vitamins may be deficient. If adequate bile does not reach the intestinal tract there occurs a marked disturbance of fat digestion and absorption. Ingested fat appears in large quantities in the faeces of animals whose bile is diverted from the intestinal tract. It is reasonable therefore to expect those vitamins which are fat-soluble to be excreted along with the undigested fat. The best known fat-soluble vitamins are D, K and A. According to Snell (*Ann. Int. Med.*, 9:690, 1935) vitamin K plus bile salts should be given as a routine measure to jaundiced patients who are awaiting operation.

Operative Treatment.—(A) *Palliative Procedures.* The abdomen is explored through a vertical epigastric incision to allow of ready access to the pancreas, gall-bladder and bile passages. At operation it is exceptionally difficult to decide whether the indurated thickening of the pancreas is due to growth or to a sclerosing pancreatitis. It is not justifiable to remove a portion of the hardened gland for microscopic investigation, for if this is done and the tumour proves to be malignant the small wound in the pancreas is difficult to suture since the tissues are friable and the sutures cut out and bleeding is uncontrollable, while dissemination of cancer cells from the bared area takes place rapidly. The majority of surgeons therefore are content to assess the true morbid anatomy by palpation and inspection, and for this reason it is not surprising to find that 7 per cent of simple cases are mistaken for malignant and that 16 per cent of cancerous cases are classified as simple.

In certain cases the diagnosis is obvious. The hard, craggy head of the pancreas feels like a malignant tumour and its extension to regions beyond the confines of the head can be made out. In other cases it may be difficult to decide whether the induration, particularly when localised to the head, is due to a circumscribed patch of chronic pancreatitis or to an impacted stone. In such circumstances it is justifiable to explore the common duct to determine whether a stone in the ampulla or slightly above it is not the cause of the local condition and of the jaundice. In other cases it may be advisable even to open the duodenum and inspect the papilla, as a stone here, or even an early growth which is amenable to surgical measures, may escape detection.

If the tumour in the head of the pancreas is found to be malignant and is also *irremovable*, the surgeon has a choice of many procedures.

He may elect to drain away the bile, either from the gall-bladder or from the common duct, on to the surface by external biliary drainage, or he may prefer to anastomose the gall-bladder to the stomach, duodenum or proximal jejunum—internal biliary drainage. In cases where the gall-bladder is absent or fibrotic and is useless for anastomotic purposes, the common bile duct may be joined to the adjacent duodenum—choledocho-duodenostomy. Finally, when the patient's condition is very poor, the surgeon may deem it wiser to do a two-stage operation, cholecystostomy being the first procedure. Later on when liver function has been re-established he can complete the anastomosis, uniting the gall-bladder to the intestine under conditions of greater security than is possible in a single-stage operation.

For the type of case we are now discussing I would most strongly urge the adoption of the two-stage procedure as a routine measure. Following the second operation, as soon as the abdominal incision has healed radiation therapy is instituted with the object of prolonging the patient's life.

Many surgeons consider that a primary cholecysto-gastrostomy is the operation of choice, and elect this method for anatomical reasons, as the distended gall-bladder lies over the pyloric region of the stomach and therefore lends itself readily to anastomosis. Cholecysto-gastrostomy, however, has the following disadvantages:

1. Leakage from the anastomotic line is common owing to the tension produced by the powerful contractions of the stomach.
2. The thick musculature and the loose redundant mucosa of the stomach lend themselves to accurate suture with the thin gall-bladder wall less readily than does the wall of the jejunum.
3. Following the anastomosis the pylorus may be kinked or partially obstructed.
4. The stoma permits of the free ingress of gastric contents into the bile radicle with the result that ascending cholangitis is a common sequel.

This operation has a mortality of about 50 per cent.

Cholecysto-duodenostomy, which is recommended as an alternative procedure, has an even higher mortality than cholecysto-gastrostomy, and technically it is more difficult to carry out as the duodenum is in a fixed position and not easily mobilised, and its walls are thin, friable and readily torn. Choledocho-duodenostomy has a death-

rate of over 70 per cent and has nothing to recommend it if the gall-bladder can be utilised.

In cases of irremovable cancer of the head of the pancreas cholecysto-jejunostomy is the ideal procedure. A loop of jejunum some 18 to 20 inches from the duodeno-jejunal flexure is selected, brought over the transverse colon and anastomosed to the fundus of the gall-bladder. The operation is completed by performing an entero-anastomosis between the proximal and distal jejunal loops 2 to 3 inches below the duodeno-jejunal flexure, after which, for added security, the omentum is wrapped round the area where the gall-bladder has been joined to the small intestine.

This operation has a lower mortality, *i.e.*, 30 per cent, and its advantages are obvious. The anastomosis can be accomplished without any tension, the suturing is simple, the junction can be made water-tight, and the entero-anastomosis deflects the intestinal contents away from the gall-bladder so that cholangitis does not occur.

The results of these palliative operations for cancer of the head of the pancreas are very disappointing as the average mortality is about 40-50 per cent (whereas in chronic pancreatitis it is 20 per cent) and within one year of the operation 90 per cent of the patients are dead. Where survival exceeds one year the question always arises as to whether the primary lesion in the pancreas was in fact cancerous or not. The mortality is higher in patients who are extremely jaundiced and where there is white bile, the death-rate in such cases being as high as 80 per cent. Post-operative deaths are caused by peritonitis, hæmorrhage, chest complications, shock and cholæmia, more than half the cases dying of cholæmia as a result of renal and hepatic damage.

Technique of Cholecysto-Gastrostomy (fig. 129 [1]). The gall-bladder is isolated, a trocar and cannula of the Mayo pattern is introduced through the fundus, and the bile is aspirated. The fundus of the collapsed gall-bladder is next seized with Ochsner forceps and drawn across to the pyloric region of the stomach to ascertain whether it can be made to lie there without undue tension. Two pairs of Allis forceps are placed, one near the lesser curvature and the other near the greater curvature about $1\frac{1}{2}$ inches from the pyloric ring, and these draw the stomach to the under-surface of the gall-bladder, about 1 inch proximal to the Ochsner clamp. The incision in the stomach

will therefore be vertical or oblique. Four or five interrupted sutures of fine silk approximate the contiguous surfaces of the pylorus and

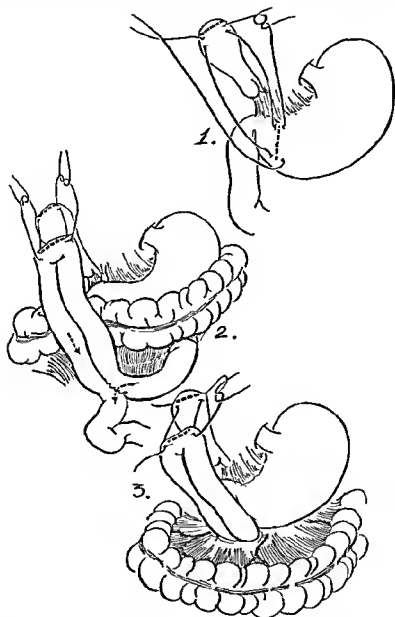


FIG. 129.—CHOLECYSTO-GASTROSTOMY AND CHOLECYSTO-JEJUNOSTOMY.

the gall-bladder and also act as tractor sutures. A continuous sero-muscular suture of fine silk is then introduced as a posterior layer, after which the stomach is opened and its contents are aspirated, the

Ochsner clamp steadying the gall-bladder being removed after that portion of the fundus which projects beyond the Ochsner clamp has been excised. After the clamps are removed the posterior margin of the gall-bladder is united to the contiguous margin of the stomach wall by a running suture, *commencing* at the greater curvature. When this reaches the lesser curvature it is continued anteriorly as a Connell or loop-on-the-mucosa suture which unites the anterior margins of the gall-bladder and stomach. When this suture reaches the greater curvature it is knotted to the end that is left long. The first posterior seromuscular suture is then picked up and continued anteriorly, invaginating the anterior suture line. When this is completed, a few interrupted sutures of fine silk are placed here and there along the suture line to reinforce it even further. The omentum is then drawn around the anastomotic line as an added measure of safety.

Technique of Cholecysto-Duodenostomy. This operation is performed without the aid of clamps. Two guide sutures are first introduced into the duodenum, fully 2 inches away from the pyloric outlet. The first suture is placed on the anterior surface of the duodenum near its outer margin, the second at a point on the inner margin of the gut but a little below the first suture (fig. 130). The fundus of the gall-bladder is clamped with Ochsner forceps and the two guide sutures are inserted at the inner and outer margins of the gall-bladder about 1 inch below the clamp, as shown in figure 130. The anastomosis is then conducted in a similar manner to cholecysto-gastrotomy, *i.e.*, by inserting two layers of continuous sutures with a reinforcement of interrupted seromuscular sutures.

Technique of Cholecysto-Jejunostomy (fig. 129 [2] and [3]). The selected loop of jejunum which should be approximately 18 to 20 inches from the duodeno-jejunal flexure is brought across the transverse colon and the selected loop is sutured about $\frac{1}{4}$ inch below the clamped fundus of the gall-bladder. A posterior continuous seromuscular suture unites the jejunum to the under-surface of the gall-bladder, and after the redundant fundus has been trimmed away and the Ochsner clamp is removed, an opening is made into the jejunum corresponding in length to the open end of the gall-bladder. A second continuous suture draws together the posterior margins of the gall-bladder and jejunum and this is continued anteriorly as a Connell



FIG. 130.—CHOLECYSTO-DUODENOSTOMY.

The essential steps of the operation are depicted

suture. The anterior suture line is invaginated by a continuous Cushing stitch and further strengthened with interrupted sutures of fine silk, after which the omentum is wrapped around the anastomosis and anchored into position with a few sutures. The operation is com-

pleted by performing an entero-anastomosis between the proximal and distal loops of the jejunum a few inches below the duodeno-jejunal flexure.

In conclusion it may be said that operation is the best course to adopt, as those that survive the ordeal are rendered more comfortable since there is relief of jaundice and of itching, life also being prolonged. Again, the difficulties in diagnosis must be stressed—a simple case may be mistaken for a malignant one. This alone would justify operation. Post-operative radiation therapy is well worth a trial.

(B) *Radical Procedures.* 1. FOR CARCINOMA OF THE TAIL AND BODY OF THE PANCREAS. Of 386 cases of cancer of the pancreas, Ewing (*Neoplastic Diseases*, 1928) found that 158 were diffuse, 156 were limited to the head, 28 occupied the body and only 12 the tail. The body of the pancreas is therefore the site of the tumour in only 7 per cent of the cases, and the tail in about 2 per cent or less.

As the disease is insidious and is seldom recognised in its early stages, radical excision of the tail and body of the organ—partial pancreatectomy—has rarely been successfully accomplished. Serafini (*Gior. d. r. Accad. di Med. di Torino*, 20:304, 1914) was the first to report a successful case of excision of the body of the pancreas for cancer. His patient, a woman, died from muscle and bone metastases two and one-half years after operation. Grekoff (*Surg., Gynec. & Obst.*, 36:327, 1923) removed about nine-tenths of a pancreas which was the seat of a large carcinoma occupying the tail and the body of the gland. The malignant nature of this tumour has, however, been questioned, partly on the strength of its tardy pre-operative development and partly because the histological description is not very convincing (Guibet).

In Grekoff's case symptoms of pancreatic deficiency appeared during convalescence and the patient required medicinal and dietary measures in order to sustain nutrition. Wedge excision of a portion of the pancreas including small langerhansian carcinomata have been reported by Roscoe Graham and his colleagues (*J. Am. M. Ass.*, 93:674, 1929) and by Judd and his co-workers (*J. Am. M. Ass.*, 99: 1933). In Graham's case a small tumour measuring about $\frac{1}{2}$ inch in diameter was excised from the body of the organ, the cut surfaces being approximated by suture and the suture line reinforced by an omental graft. It was only after microscopic examination that the

tumour was found to be a localised carcinoma of the islets of Langerhans.

Gordon-Taylor has given a detailed and vivid account of the heroic and highly successful operation he performed upon a man with carcinoma of the body of the pancreas. He writes:

Almost seven years have now elapsed since the removal of a massive carcinoma of the body of the pancreas was performed in the case under consideration; and a recent visit of the patient in an excellent state of health, and in possession of boundless mental and physical energy, prompts the presentation of this note. The following account does not purport to be a narrative of some stupendous or venturesome operation, but merely embodies a hope that others may be encouraged to radical measures should it be their fortune to encounter a similar set of conditions. Moreover, the possibility of an enduring cure as a recompense for surgical fortitude would seem to justify a bolder attitude than has been customary in this disease. . . .

All writers remark on the mechanical difficulties of the operative removal of cancer of the pancreas, and it may be that this present case, now in the enjoyment of vigorous manhood, is only the exception that goes to prove the rule that "if boldness and good fortune are the operator's gifts, the result to the patient hardly justifies the means."¹

The tumour is best approached through a long vertical or transverse epigastric incision, and the pancreas freely exposed by unpicking the great omentum from the transverse colon and by completely severing the gastro-splenic omentum, after which the omentum and stomach are drawn firmly upward over the chest and held there in the grasp of an assistant's hands. After ligaturing and dividing the left gastro-epiploic artery, the spleen is mobilized and drawn through the abdominal incision. *After the splenic artery and vein have been ligated* and the tail and body of the pancreas have been freed from their posterior attachments, the gland is cut across in the region of the neck, well beyond the visible and palpably growing margin of the tumour. Bleeding points in the cut surface of the pancreas are picked up with mosquito forceps and tied with fine silk or underrun and ligated, whilst diffuse oozing areas are best controlled by coagulation with a blunt-pointed diathermy needle. The cut surface of the gland is now oversewn with mattress sutures and wrapped around with omentum. Drainage should always be provided.

¹ Gordon-Taylor, *Ann. Surg.*, 100:206, 1934. Courtesy of J. B. Lippincott Co.

2. FOR CARCINOMA OF THE AMPULLARY REGION AND THE HEAD OF THE PANCREAS. Since Cohen's and Colp's paper (*Surg., Gynec. & Obst.*, 45:332, 1927) on the operative treatment of cancer of the peri-ampullary region of the duodenum was published, a great deal of interest has been aroused as to the best method of surgical attack in cases of malignant disease of the head of the pancreas and of the lowest portion of the common bile duct. Whipple, Parsons and Mullins (*Ann. Surg.*, 102:763, 1935) laid the foundations of the present-day two-stage operation. These writers carefully analysed 69 cases of cancer of the head of the pancreas and of the ampulla of Vater subjected to radical operation. Brunschwig (*Surg., Gynec. & Obst.*, 65:681, 1937) later described a most ingenious two-stage operation. His patient lived for 85 days, and at necropsy carcinomatosis of the peritoneal cavity and multiple liver metastases were found.

A review of all the published cases shows that the immediate post-operative results are poor and that the late results are dreadful. Nevertheless, cure—or, to be more exact, prolonged palliation—is possible following radical pancreatico-duodenectomy, and in this connection I may cite Whipple's patient who is alive and well two years after this operation, having gained 30 pounds in weight.

Whipple (*Am. J. Surg.*, 40:260, 1938), to whom the profession is indebted for his research and valuable work in this field, and who has done much to simplify the various stages of the radical procedure, advises that the operation should be carried out in two stages, since all these patients are deeply jaundiced, emaciated and depleted, and are threatened with the hazard of uncontrollable bleeding and visceral shock in an extensive operation.

At the first operation the gastro-duodenal artery is tied, the common bile duct is ligated just below the cystic duct, and an antecolic cholecysto-jejunostomy on the Roux-in-Y principle of anastomosis is carried out. The distal cut end of the jejunum is anastomosed to the fundus of the gall-bladder and an end-to-side anastomosis of the proximal cut end of the jejunum to the side of the jejunum is performed. 4 to 5 inches below the cholecysto-jejunostomy (fig. 131 [1]).

At the second operation two or three weeks later a posterior gastro-jejunostomy, with the stoma lying transversely and close to the greater curvature, is done, this being followed by excision of the first, second and a portion of the third part of the duodenum, the ampulla of

Vater with the lower end of the common bile duct and a generous wedge-shaped portion of the head of the pancreas, with ligation of the cut end of the duct of Wirsung, closure of the pancreatic stump with

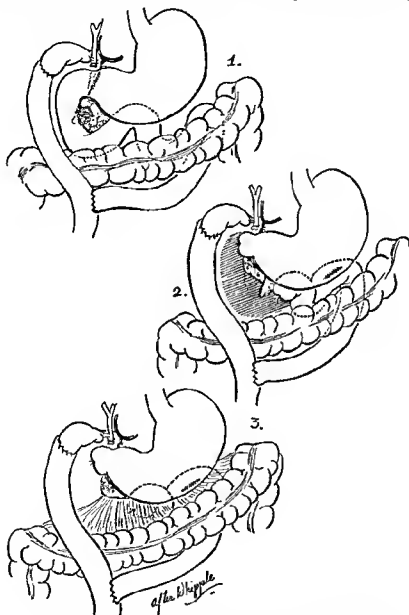


FIG. 131.—RADICAL OPERATION FOR CARCINOMA OF THE AMPULLARY REGION OF THE HEAD OF THE PANCREAS—WHIPPLE'S TECHNIQUE.

interrupted silk sutures and closure and invagination of the proximal and distal duodenal stumps (fig. 131 [2] and [3]). The retroperitoneal

area formerly occupied by the duodenum and head of the pancreas is drained with rubber tubes.

In the Brunschwig technique a long loop of proximal jejunum is drawn through the mesocolon for anastomosis to the fundus of the gall-bladder, and when this anastomosis has been completed a side-to-side jejuno-jejunostomy is performed.

The first stage of the operation is completed by performing a short-circuit posterior gastro-jejunostomy. At the second stage, usually a month later, the duodenum and the head of the pancreas are mobilized by Kocher's method, the pyloric sphincter is divided, the common bile duct tied below the cystic duct, and cut across just below this. A large grooved director is passed beneath the neck of the pancreas and over the superior mesenteric vein and artery, and the gland is transected over the director with a cautery. The commencement of the third part of the duodenum is freed, clamped and divided, and its distal end securely invaginated. The cut end of the stomach is turned in, the raw surface of the pancreas ligated with mattress sutures, and drainage of the operative field provided. There may be a little leakage of blood-stained pancreatic juice for a few days following operation, but as a rule this soon ceases spontaneously.

The patient is of course deprived of pancreatic digestive juices, but the internal secretion remains unaffected. It is surprising how these patients rapidly gain weight following the operation and how little they are inconvenienced by the absence of pancreatic juice. Pancreatic extracts, and especially pre-digested foods, may be prescribed, but these are not generally required.

Whipple gives a brief account of the records of 11 operations in which the head of the pancreas and the major portion of the duodenum were excised for growth involving the pancreatic head or the lower end of the common bile duct. There were six post-operative deaths and two years after the operation of the patients who survived only one was alive and well.

INNOCENT NEW GROWTHS—ADENOMATA OF THE ISLET CELLS WITH HYPERINSULINISM

Deficiency of the internal secretion from the islands of Langerhans—diabetes—does not primarily concern the surgeon except in so far

as some of its remote complications require treatment. But hypersecretion of the islet tissue as the result of over-activity, adenoma or carcinoma, is of great surgical interest and produces a definite syndrome which, if recognised in good time, will prove amenable to surgical measures. One is reminded, as Sellors (*Post-Grad. Med. J.*, 14:211, 1938) has said, of the similarity between the rapid increase in knowledge of hyperparathyroidism and that of hyperinsulinism—small active tumours of endocrine tissue dominating from their special angles the whole picture of metabolism. The effect of this internal overdosage of insulin is to reduce the blood sugar to such an extent that hypoglycæmic symptoms appear. It should be remembered that the control of the blood sugar is not solely dependent upon the islands of Langerhans secreting insulin, but is affected also by the pituitary, the suprarenals, the liver, and the thyroid. Hypoglycæmia also occurs in the terminal stages of diabetes, after the withdrawal of insulin, in exhaustion of the glycogen reserve such as is found in many diseases of the liver, and in the muscular dystrophies. Nicholls (*J. Med. Research*, 8:385, 1902) was the first to report a case in which at necropsy a solitary adenoma arising from islet tissue was found, while Lang (*Arch. f. path. Anat.*, 257:235, 1925) published the first account of a case of multiple adenomata—adenomatosis. Harris (*J. Am. M. Ass.*, 83:729, 1924) in his stimulating article suggested that there was a clinical possibility of spontaneous hyperinsulinism as opposed to the hypo-insulinism of diabetes, and Wilder and his colleagues (*J. Am. M. Ass.*, 89:348, 1927), benefiting by Harris's research, were the first to operate upon a case of tumour of the pancreas associated with hyperinsulinism. At operation they found a primary carcinoma arising from the islet cells which had produced metastatic implants in the liver, in the regional lymphatic nodes and in the mesentery. Following the report of his case, which stimulated interest in the subject, Roscoe Graham, Allan, Finney, Carr and Whipple described their experiences and results in patients who were successfully operated upon for adenomata of the islet cells associated with hypersecretion of insulin. Whipple and Frantz (*Ann. Surg.*, 101:1299, 1935) were able to report 35 cases in which operation had been performed up to 1935. These authors gave a detailed description of six personal cases.

In severe cases of hyperinsulinism the ingestion of several pounds of sugar a day may fail to control the symptoms which are chiefly

vasomotor and nervous. Wilder grouped the symptoms as follows: (1) those relating to disturbance of the sympathetic nervous system; (2) those of the central nervous system, and (3) those of psychic origin.

The symptoms as a whole vary from mild feelings of lassitude and fatigue, restlessness and apprehension, often with a marked desire for food (especially carbohydrates) to convulsive fits, delirium and coma. Following the intake of quantities of carbohydrates the patient may feel quite well. In a severe case the clinical picture may closely resemble that of insulin shock. The hypoglycæmic state has often been confused with epilepsy and alcoholism, and it is not surprising that many of these patients are found in mental institutions.

During the attacks the blood sugar is low, the recorded figures varying from 4 to 58 mgm. per cent.

After the diagnosis of chronic hypoglycæmia has been established and hepatic, thyroid, pituitary and other extra-pancreatic causes have been eliminated, the patient should be given a course of medical treatment for two or three weeks to determine his response to conservative measures. If it is found that the blood sugar values are continuing to remain low, *e.g.*, 50 mgm. per cent or lower, and that the fits and attacks can be controlled with a high carbohydrate intake, exploratory laparotomy is indicated.

Operative Treatment. A few hours before operation is undertaken the patient is given 500 cc. of a 10 per cent solution of glucose intravenously and the stomach is emptied of fluid and gas by aspiration. Most surgeons prefer spinal anæsthesia, as complete relaxation is essential, but McCaughan prefers ether anæsthesia because of its reputed effect in sustaining and even elevating the normal level of the blood sugar. Whipple recommends a transverse epigastric incision, but here again there are a number of surgeons who maintain that a long paramedian incision gives adequate access to the pancreas.

If the stomach is somewhat ptosed, the organ may be approached by free division of the gastrohepatic omentum, but in the average case access is obtained by a liberal division of the gastro-colic omentum. It is essential that the whole organ—the head, the tail and the body of the pancreas—should be visualised (fig. 132).

When the gastro-colic omentum is divided, a large pack should be placed behind the stomach and the viscus should be rotated and re-

tracted firmly upward, while a pack over the transverse colon aids the assistant in its displacement downward. The abdominal incision should be widely retracted with Deaver retractors. The bridge of the operating table should now be elevated to arch the back and to bring the pancreas closer to the surface. The whole gland must then be care-

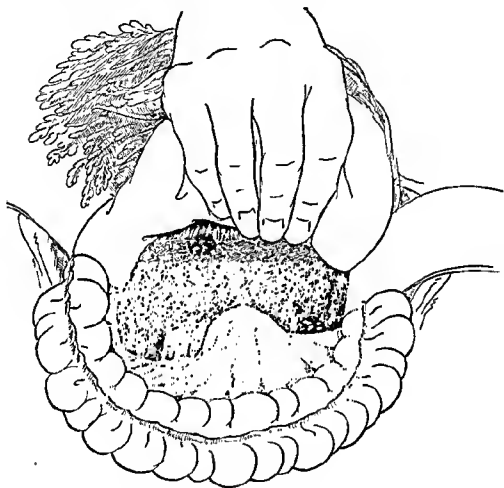


FIG. 132.—OPERATION FOR ADENOMA OF THE PANCREAS.
The exposure.

fully inspected and palpated. An adenoma is usually seen as a small rounded body, $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter, purplish-pink in colour, and readily recognisable in the yellowish-white substance of the pancreas. It is covered with numerous small blood vessels which bleed freely while the adenoma is being shelled out of its capsule. If one

adenoma is found, a search should be made for others by exploring the anterior and posterior surfaces of the gland. If the anterior surface appears to be normal, the pancreas should be mobilised by incising the inferior peritoneal attachment and by gently elevating it to permit inspection and palpation of its posterior aspect. A good exposure of the under-surface of the head of the pancreas can be obtained by mobilizing the duodenum and this portion of the pancreas by Kocher's method. Multiple adenomata are chiefly found in the body and tail of the gland. If no adenoma is found, at least two-thirds of the pancreas, including the tail, the body, the neck and a portion of the head, should be excised.

There are many ways of performing *partial pancreatectomy*, but the technique employed by McCaughan (*Ann. Surg.*, 101:1336, 1935) is the one which appeals to me most, and is here illustrated (fig. 133). The operation is started by dividing the peritoneum at the lower margin of the pancreas near its tail. The tail of the pancreas is then seized and drawn forward and downward to put the splenic vein and artery on the stretch. A tape tractor is passed around the splenic artery, and another around the splenic vein, as illustrated in figure 133 (1), not only to draw these blood vessels out of the way but also to facilitate the ligature of the numerous branches which run between these vessels and the pancreatic tissue. The task of separating the splenic vein and splenic artery from the adherent pancreatic tissue is tedious, but as McCaughan says, with patience it may be accomplished with success.

Each little individual blood vessel should be underrun with a fine aneurysm needle and tied off carefully in two places with silk. One fairly large artery, the *pancreatica magna*, enters the upper portion of the body of the gland and should be isolated and ligatured early in the dissection. The dissection is continued until the region of the neck and head is reached. As much of the gland as may seem necessary according to the severity of the symptoms can then be removed, and it is possible to excise at least 90 per cent of the pancreas without producing permanent glycosuria. The tendency is to remove too little rather than too much.

When the major portion of the gland has been dissected free, a right-angled clamp with rubber covered blades is applied to the head of the pancreas to control bleeding during the excision. The pancreas

is next divided with a cautery with a V-type of incision, and the stump is securely closed, either with interrupted mattress sutures or with a continuous lockstitch of silk (fig. 133 [2] and [3]). This affords excellent hæmostasis.

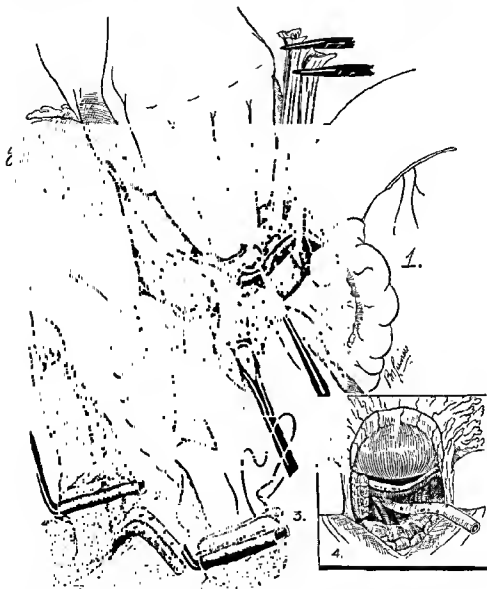


FIG. 133.—PARTIAL PANCREATECTOMY FOR HYPER-INSULINISM—McCAUGHAN'S TECHNIQUE.

A Penrose drain is then led down to the cut margin of the pancreas and should be made to appear at the lower margin of the abdominal

incision (fig. 133 [4]). There is always a fair amount of pancreatic juice secreted, and it is a wise plan to leave this tube in position for many days until it is evident that leakage has ceased. The discharge is not proteolytic to any degree, and does not cause digestion of the wound unless there has been sepsis, in which case there will be excoriation of the skin of the abdominal wall unless this has been protected by the measures already advocated.

Holman and Railsback (*Surg., Gynec. & Obst.*, 56:591, 1930) and Thomason (1934) deliberately sacrificed the spleen as a measure of simplifying the operation. The splenic artery and vein are ligated and this of course controls the hæmorrhage, but I am convinced that with due care and patience the resection can be accomplished without recourse to this manoeuvre, and unless the main vessels are accidentally injured their ligation and consequent splenectomy should not prove necessary.

The results of the operation are most gratifying and the removal of a small tumour of islet tissue from the pancreas results in marked improvement, while in the majority of cases complete cures are recorded. Up to the present day, some 60 cases of removal of an adenoma of the islet cells of the pancreas have been reported with a mortality of about 5 per cent. In Whipple's and Frantz's series (1935) of 35 cases there were no fatalities and all the patients from whom adenomata had been removed were cured completely of their hypoglycæmia. In some of the cases of partial pancreatectomy the excised gland tissue was found to contain one or more small adenomata which had not been detected at operation, and in others microscopical examination showed that there was an excess of islet tissue. In this latter group the expectation of post-operative relief appeared to depend principally upon the amount of pancreatic tissue excised. In a general way it seemed that the more radical the removal the better were the results.

PART V

GALL-BLADDER AND BILE DUCTS

CHAPTER 1

ANOMALIES AND INJURIES

The surgeon should be familiar not only with the anatomy of the gall-bladder, biliary passages and associated blood vessels, but also with the various abnormalities which may from time to time be encountered during the operation upon them.

ANOMALIES OF THE GALL-BLADDER

Congenital anomalies of the gall-bladder are rare. Gross (*Arch. Surg.*, 32:131, 1936), who made a special study of this subject, was able to collect 148 cases from the literature. He grouped the different types as follows:

1. **Anomalous Forms:**

- (a) Double gall-bladder.
- (b) Bi-lobed gall-bladder.
- (c) Diverticulum of the gall-bladder.
- (d) Miscellaneous malformations.

2. **Total Absence of the Gall-Bladder.**

3. **Anomalous Positions:**

- (a) Intra-hepatic gall-bladder.
- (b) Gall-bladder on the left side.
- (c) Retro-displacement.
- (d) Transverse position.
- (e) Floating gall-bladder.

In the condition termed *double gall-bladder* there are two separate organs and two separate cystic ducts. Clyde Wilson (*Ann. Surg.*, 110:60, 1939) states that duplication of the gall-bladder is rare, occurring only about once in every 3,000 to 4,000 human beings. The two cystic ducts may converge and form a joined cystic duct which enters the main bile duct (Y-shaped type), or the two cystic ducts may empty

separately into the extra-hepatic biliary system (ductular type). In the latter variety the termination of the second or accessory cystic duct may be either in the common duct or in one of the hepatic ducts. An accessory gall-bladder may lie hard against the normal organ in the normal gall-bladder fossa, or it may be situated elsewhere, *e.g.*, under the left lobe of the liver, in which case it may communicate with the left hepatic duct. The size of the accessory gall-bladder usually approximates that of the normal gall-bladder, but occasionally it is considerably smaller and may be globular instead of pyriform.

Anomalous gall-bladders which arise from the common duct by a narrow neck lie along the free margin of the gastrohepatic omentum and are invariably small and rudimentary, measuring from $\frac{1}{2}$ to $\frac{3}{4}$ inch in length.

Gross carefully analysed and tabulated 28 cases of double gall-bladder which he was able to collect from the literature, and it is interesting to see Sherren's name heading the list as the first surgeon to record a case in which double gall-bladder was successfully removed. This specimen is now preserved in the Hunterian Museum of the Royal College of Surgeons. Sherren gave a detailed account of this case in the *Annals of Surgery* (54:204, 1911).

Schachner's case (*Ann. Surg.*, 64:419, 1916) was one of great interest. He operated upon a patient aged 52 for acute cholecystitis and on finding a double gall-bladder he drained each viscus. In Wakeley's case (*Brit. J. Surg.*, 15:334, 1927) a double gall-bladder of the Y-shaped variety was successfully excised and on examination one sac was found to contain many stones, while the other contained only bile and mucus. Up to the year 1939 no fewer than 37 cases of double gall-bladder have been reported. Boyden (*Am. J. Anat.*, 38:177, 1936) 20 cases; Slaughter and Trout (*Am. J. Surg.*, 19:124, 1933) 12 cases; Weiss (*Diseases of the Liver, Gall-Bladder, Ducts and Pancreas*, 1935) 3 cases; Gross (1936) 1 case; and Clyde Wilson (*Ann. Surg.*, 110:60, 1939) 1 case.

According to Gross the presence of the congenital anomaly is often not diagnosed before operation or at autopsy, because there are no characteristic symptoms or signs. When the accessory organ is the seat of inflammatory change or stone formation, the symptoms and signs closely resemble those occurring with cholecystitis or cholelithiasis in a normally formed gall-bladder. The mere presence of a second vesi-

cle has not clearly given rise to symptoms in any case. It is difficult to state whether or not an accessory organ is more prone to be involved by disease processes, but the fact that most of these anomalies have been discovered during operations and only a few at post-mortem examination certainly indicates that the accessory structure is probably more likely to have pathologic changes than is a normally formed organ.

Examination by means of X-rays has demonstrated a duplicate gall-bladder in five instances. Cave (*Lancet*, 1:751, 1931) recorded two examples of double gall-bladder which were detected by cholecystography, but unfortunately in neither case was the diagnosis confirmed by exploratory laparotomy. Weiss (1935) reported three cases of double gall-bladder diagnosed by cholecystography, two with calculi. He pointed out that in order to be included under the classification of double gall-bladder, each gall-bladder should have its own cystic duct, thus differentiating it from the bifid gall-bladder in which the cavities are distinctly separate but communicate with the common bile duct through a single cystic duct.

Craham, Cole, Copher and Moore (1928) were unable to find a single example of double gall-bladder in 1,218 cases of suspected gall-bladder disease examined by the dye test.

Bi-lobed gall-bladder is seldom encountered in man, there being only six cases on record. A bi-lobed gall-bladder may have the shape of a single organ divided by an internal central septum, or, more often, it may be V-shaped, the two cavities joining into a common infundibulum which empties into a normally situated and normally formed cystic duct.

A *diverticulum of the gall-bladder* may occur in any position along the surface of the organ from the fundus to the neck. The commonest site for such a diverticulum is in Hartmann's pouch. Beluffi (1939) described a case of congenital intra-parietal diverticulum of the fundus of the gall-bladder. These diverticula vary in size from $\frac{1}{4}$ to $1\frac{1}{2}$ inches in diameter. Only a few of them have been observed at operation, but they are occasionally seen when the gall-bladder is examined at cholecystography.

In Gross's series there were 38 cases of *absence of the gall-bladder* in which there was no other anomaly of the liver or biliary apparatus. About 35 other cases of absence of the gall-bladder have been re-

corded in which there was associated congenital atresia of the extra-hepatic ducts.

A normally formed gall-bladder has been found: (1) within the hepatic substance; (2) under the left lobe of the liver; (3) posteriorly under the inferior aspect of the right lobe of the liver; and (4) horizontally in the transverse fissure of the liver.

There are two common types of *floating gall-bladder*. In the first the cystic duct may possess a well-marked mesentery, while the gall-bladder lies free, being *entirely* invested with peritoneum. In the second variety the gall-bladder and cystic duct are suspended from the liver by a well-marked mesentery. This condition is by no means rare, and is seen in some 5 per cent of all gall-bladders, 84 per cent of the cases occurring in women and 16 per cent in men. Its main interest lies in the fact that only when the gall-bladder has a long mesentery or is quite free is it capable of undergoing torsion.

It is a strange fact that *torsion of the gall-bladder* occurs only in late life, the maximum incidence being between the ages of 60 and 70. It is difficult to understand why this should be so, but it may possibly be due to the fact that with advancing age the supporting fat tends to disappear from the surrounding structures, and when atrophy of the tissues permits increased ptosis of the viscera including the gall-bladder, there is an increase also in the mobility of the vesicle which predisposes it to twisting.

Nearly all patients who suffer from torsion of the gall-bladder are thin, asthenic and visceroptotic. When torsion occurs the patient experiences abrupt and acute pain below the right costal margin, which continues unabated with extreme severity. Immediately after the onset, collapse is marked, vomiting is frequent and the temperature quickly mounts. Although at first the pulse-rate may be only 100, it will soon rise to 120 and in an extreme case even to 150. The pain, although mainly localised to the right of the epigastrium, is often keenly felt below the right shoulder blade. Over the gall-bladder, which may be palpable, the symptoms of tenderness and rigidity may also be observed.

A diagnosis of acute obstructive cholecystitis is usually made and operation frequently advised during the first forty-eight hours. It is well that this is so, since after this time peritonitis rapidly ensues owing to gangrene and perforation of the organ. At operation the

gall-bladder will be seen to be tensely swollen, œdematous, hæmorrhagic or necrotic, and may be red, dark brown or black in colour. The true state of affairs is immediately recognised, as the twisted pedicle and infarcted gall-bladder present a characteristic picture.

The *treatment* is simple and consists in isolating the cystic duct and artery, and ligaturing and dividing them, after which the loose attachment of the gall-bladder to the liver is clamped and severed and the organ removed. In the series of 50 patients subjected to cholecystectomy there was a mortality of about 15 per cent.

ANOMALIES OF THE ARTERIES

Eisendrath, Harberland, Holmes, Kehr, Ladd, Friend, Flint and others have ably drawn attention to the normal and the abnormal arrangements of the arteries in relation to the gall-bladder and biliary passages, and have emphasised their surgical importance. The following is a brief summary based chiefly upon the anatomical studies of Flint (*Brit. J. Surg.*, 10:509, 1923):

The *right hepatic artery* arises from the main hepatic trunk in 80 per cent of cases, and reaches the liver by passing behind the common hepatic duct in 68 per cent of cases and in front in 12 per cent (fig. 134). In 21 per cent of cases the right hepatic artery originates from the superior mesenteric artery, and when this is so it invariably runs upward toward the portal fissure behind the common duct. In some 3 per cent of cases there are two right hepatic arteries, one arising from the main hepatic artery and the other—usually a smaller branch—from the superior mesenteric artery. In 1 per cent of cases there are two right hepatic arteries, both arising from the common hepatic trunk. One blood vessel passes in front and the other behind the main bile duct.

The right hepatic artery is likely to be injured during cholecystectomy:

1. When it lies parallel with and close to the cystic duct (fig. 135).
2. When it forms a loop in front of or a ring around the common hepatic duct.
3. When it projects markedly forward, forming as it were a knuckle close to the upper margin of the neck of the gall-bladder before sweeping backward to the portal fissure.

4. When the gall-bladder has a mesentery, as in such cases the artery often lies within this on its way to the right lobe of the liver.
5. When it is dragged out of position by a sclerosing gall-bladder.

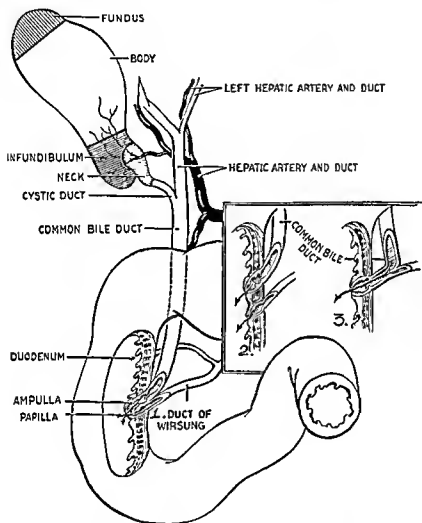


FIG. 134.—ANATOMICAL SUB-DIVISION OF THE GALL-BLADDER AND BILIARY PASSAGES

The normal arrangements of the arteries and the modes in which the common bile duct and pancreatic duct enter the second part of the duodenum.

When this artery lies across the common hepatic duct it may also be inadvertently clamped or divided during a difficult cholecystectomy or during a secondary operation upon the bile passages. When

there is a wide communication between the gall-bladder and bile duct, and no cystic duct is present, the right hepatic artery, which may be lying behind the gall-bladder, may be traumatised when clamping or dividing the broad isthmus.

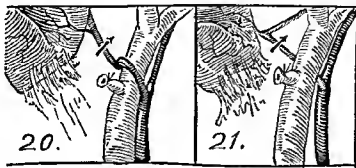


FIG. 135.—THE RIGHT HEPATIC ARTERY IS LIABLE TO INJURY DURING CHOLECYSTECTOMY WHEN IT LIES PARALLEL WITH AND CLOSE TO THE CYSTIC DUCT.

The *cystic artery* springs from the right hepatic artery in 96 per cent of cases (fig. 136). In the remaining 4 per cent it arises from the left hepatic artery, from the main parent trunk, from the junction of the right and left hepatic arteries, or even from the gastro-duodenal artery. In 16 per cent of cases it passes in front of the common hepatic duct, while in 84 per cent it arises to the right of or immediately posterior to this duct.

An *accessory cystic artery* is found in 12 per cent of cases. In 8 per cent two cystic arteries arise from the right hepatic artery. In 1 per cent of cases:

1. One artery arises from the right hepatic artery and the other from the gastro-duodenal artery.
2. The accessory artery arises from the main hepatic trunk.
3. Both vessels arise from the left hepatic artery.

When an accessory cystic artery is present it almost invariably passes in front of the bile ducts. Ignorance of the presence of accessory cystic arteries may be responsible for a severe hæmorrhage during the preliminary dissection which is necessary prior to cholecystectomy or exploration of the common duct.

The *gastro-duodenal artery* is of importance in surgery of the common bile duct, as in 20 per cent of cases it crosses in front of the

common duct, while in a further 36 per cent it reaches across the left border of the duct. In 76 per cent of cases the pancreatico-duodenal artery, which is a branch of the gastro-duodenal artery, crosses the common bile duct.

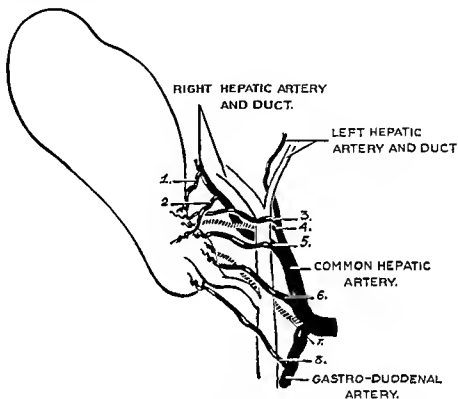


FIG. 136.—FIGURE TO SHOW THE GREAT VARIATIONS IN THE ORIGIN AND COURSE OF THE CYSTIC ARTERY.

(1) and (2) Cystic artery springing from the right hepatic artery in more or less usual position.

(3) Cystic artery arising from the left hepatic artery and passing to the gall-bladder in front of the common hepatic duct.

(4) Cystic artery arising from the left hepatic artery and passing behind the common hepatic duct.

(5) Cystic artery arising at the junction of the hepatic arteries and passing in front of the common hepatic duct.

(6) Cystic artery arising from the common hepatic artery and passing towards the gall-bladder in front of the common hepatic duct.

(7) Cystic artery arising from the common hepatic artery and passing behind the common hepatic duct.

(8) Cystic artery arising from the gastro-duodenal artery.

ANOMALIES OF THE BILE DUCTS

The right and left hepatic ducts unite in the portal fissure or just below it to form the common hepatic duct which is usually 1 to 1½ inches in length (fig. 137). The cystic duct, which is normally about the same length, unites with the common hepatic duct to form the common bile duct which in most individuals is about 3 inches long. But the length of the supra-duodenal portion of the common bile duct varies with the level of the duodenum and also with the point at which the cystic and common hepatic ducts join. In some cases the cystic duct is absent, and when this is so the neck of the gall-bladder—or rather the infundibulum—enters the main bile passages by a wide mouth (fig. 137C).

The medial aspect of the lower quarter or half, or sometimes even more, of the cystic duct is often firmly adherent to the lateral margin of the common bile duct, being fixed to the duct by bands of fibrous tissue (fig. 137B). The cystic duct may join the common duct at any point between the usual anatomical position (*i.e.*, within ½-inch of the upper border of the duodenum) and the ampulla of Vater, and in exceptional circumstances it may even open into the second portion of the duodenum separately (fig. 137A).

The cystic duct normally opens on the right side of the main bile duct, but in 8 to 10 per cent of cases it enters on the anterior surface, the posterior surface, or even on the left (medial) side, twisting spirally around the main duct (fig. 137A [3] and [5]).

An *accessory bile duct*, which is in fact an accessory right hepatic duct, emerges from the portal fissure, lies at a somewhat posterior plane to the cystic duct and usually unites with the extra-hepatic ducts at some point between the union of the right and left hepatic ducts and the opening of the cystic duct into the main bile duct. An accessory cystic duct may open:

1. Into the neck of the gall-bladder (fig. 137D [1]).
2. Into the right hepatic duct (fig. 137D [2]).
3. Into the right side of the common hepatic duct (fig. 137D [3]).
4. At a point at or very close to the site where the cystic and common hepatic ducts join (fig. 137D [4] and [5]).

An accessory cystic duct is usually about the same size as a normal cystic duct, but in some cases it may be minute. An undetected injury

to one of these accessory ducts during cholecystectomy may subsequently produce a troublesome external biliary fistula or a localised or generalised peritonitis.

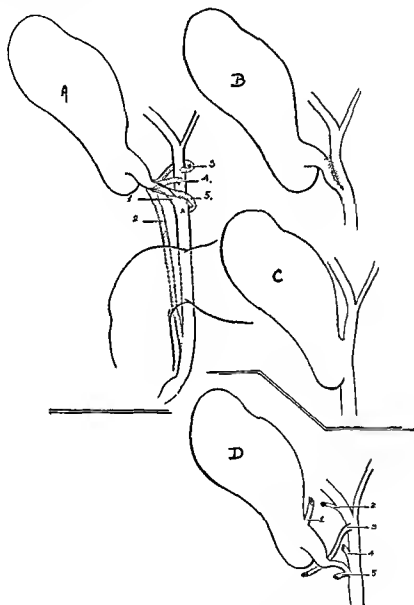


FIG. 137.—ANOMALIES OF THE BILE DUCTS.

As has been emphasised, injuries to the extra-hepatic ducts and their associated blood vessels occur most frequently during excision

of the gall-bladder. Such injuries should not arise if the surgeon ensures good exposure of the parts at operation, if he constantly bears in mind during every gall-bladder operation that such variations as I have described are by no means uncommon, and if he makes it a rule never to clamp or divide any structure in this region until he has identified it beyond all cavil and demonstrated it to an assistant.

Congenital Obstruction of the Bile Ducts. Holmes (*Am. J. Dis. Child.*, 11:405, 1916) collected 120 cases from the literature and described a large number of variations in malformations. Ladd (*Ann. Surg.*, 102:742, 1935), who based his instructive article on the study of 45 cases of congenital obstruction of the bile duct occurring in the Children's Hospital, Boston, considers that while it is true that almost no two cases are precisely alike, it is nevertheless possible to classify the various malformations into a small number of groups. The following arrangement has been suggested.

1. Cases in which there are no extra-hepatic ducts.
2. Cases in which there is an atresia of the hepatic ducts.
3. Cases in which there is an atresia of the common bile duct.
4. Cases in which the gall-bladder is represented as a moderate-sized cyst, not connected with the common duct, and in which there may or may not be any common or hepatic ducts.
5. Cases in which the gall-bladder connects directly with the duodenum, but in which there are no other extra-hepatic ducts, *i.e.*, no ducts connecting the liver and gall-bladder or the liver and intestine.
6. Cases where there is a stenosis of the common duct, which is plugged with inspissated bile causing complete obstruction.
7. Cases in which there is narrowing of the common duct, causing partial obstruction.

The clinical picture is similar in most cases. At birth the child is usually normal and progresses favourably until about the second or third week of life, when jaundice becomes evident. This at first is mild, the skin being merely tinted pale yellow, but it gradually increases until at the end of a month or so it is very intense and gives rise to a greenish-yellow hue. The liver at the same time slowly enlarges and feels unduly hard on palpation, its edge being rounded and firm. The stools are usually white, putty-like and acholic, while the urine is bile-laden and tinted dark brown. The icteric index varies in different patients and from day to day in the same patient, ranging

mostly between 50 and 200. The blood picture shows no gross abnormality, the red cells are not unduly fragile, although they may be somewhat reduced in number, and a positive van den Bergh reaction is obtained in all cases. The condition may be confused with icterus neonatorum, erythroblastosis (icterus gravis), jaundice of hæmolytic sepsis, or congenital syphilis. Every attempt should be made to reach a diagnosis within the first two months of life and not to delay operation beyond the fourth month, as the majority of patients will die within six months if the obstruction is not relieved.

The diagnosis can be arrived at with a fair degree of certainty by the end of the second month of life by a process of elimination, and sometimes earlier than this. Ladd considers that some 37 per cent of cases present possibilities of cure. Nine (or 60 per cent) of the patients in his series who were operated upon for complete obstruction recovered and have remained in good health for periods varying from six months to ten years. The mortality of the patients with complete obstruction without operation is obviously 100 per cent.

Operative Treatment. The best incision in these small infants is a right paramedian or a right transrectus (muscle split) incision. Considerable difficulty may be experienced in determining the type of malformation which is present. All the structures are small, the anomalies show wide variations, and there may be anomalous folds of membrane from the duodenum and transverse colon which tend to obscure the operative field. If the gall-bladder is present and the common bile duct cannot be seen, a wise manoeuvre consists in inserting a catheter into the fundus of the gall-bladder and distending the gall-bladder with a saline solution. When the cystic duct is patent and the common bile duct is present, the fluid will distend the common bile duct and bring it rapidly into view. In some cases in which the lower reaches of the common bile duct are plugged with inspissated bile, this method may be sufficient to produce displacement of the clot and cause it to pass into the duodenum, thus relieving the obstruction. Where, however, there is a definite stenosis of the common bile duct, although cholecysto-gastrostomy has been frequently practised for the relief of this condition, there is no doubt that choledocho-duodenostomy, when feasible, is a far superior operation in spite of its having greater technical difficulties.

When choledocho-duodenostomy is a feasible procedure, the lower

end of the common duct should be freed and divided, and a small rubber tube should be inserted upward toward the common hepatic duct. This tube is then tied securely to the lower end of the common duct. In the adjacent anterior wall of the duodenum a purse-string suture is inserted, and in the centre of this a small opening is made with the tips of the mosquito hæmostat and enlarged sufficiently to accommodate the common duct together with its enclosed tube. The tube and common duct are then led through the opening in the duodenum for a short distance, after which the purse-string suture is tied. The duct is further secured by stitching it all around to the duodenal wall with interrupted mattress sutures of fine silk. In due course the small rubber tube is passed into the intestine and a good anastomotic junction is achieved by this simple procedure.

Congenital Cystic Dilatation of the Common Bile Duct—Choledochus Cyst. In the majority of the recorded cases the cyst has involved the supra-duodenal portion of the common bile duct. It is probably, at first, one of the achalasic conditions, but when the cyst reaches a certain size a valvular flap appears at the outflow from the dilated portion of the duodenum so that the condition passes from a passive dilatation to one of obstruction.

Gross (*J. Pediat.*, 3:730, 1933) attempted to assess the relative merits of the various theories advanced to explain the origin of choledochus cyst and analysed 100 authentic cases which he was able to collect from the literature. Of these 100 patients 52 had had symptoms from the ninth year of life or earlier; 45 of the 52 were under 15 years of age, whereas 32 of the 45 were under the age of 10 at the time of the discovery of the cyst.

The anomaly is four times commoner in females than in males. The cyst varies considerably in size, the largest on record—that of Neugebauer—contained one gallon of bile.

During the last six years five additional cases have been reported. The following writers have each described one case: Weber (*Brit. J. Child. Dis.*, 31:113, 1934), Duff (*Brit. J. Surg.*, 21:536, 1934), Swartley and Weeder (*Ann. Surg.*, 101:912, 1935), Dickson Wright (*Post-Grad. Surg.*, 1:733, 1936), and Bodley (*South. Surg.*, 6:126, 1937). The rarity of the condition may be gauged by the fact that Judd and Greene (*Surg., Gynec. & Obst.*, 46:317, 1928) in 17,381 operations on the bile ducts discovered only one case.

The symptoms and signs, however, are sufficiently characteristic to make the disease readily recognisable if the surgeon is fully acquainted with the gross anatomy of the lesion. The patient is usually a young girl who has a smooth spherical tumour on the right side of the abdomen which is continuous with the liver dulness. The tumour, which feels solid when it is tense with fluid, is movable from side to side but not in an upward or downward direction. There may be a point of colonic resonance over it. There may be no symptoms, or on the other hand there may be signs of biliary or duodenal obstruction such as intermittent jaundice, colic, cholangitic fever and rigors if the former, and occasional attacks of vomiting, indigestion and flatulence if the latter. X-rays are of the greatest value in diagnosis. For instance:

1. Excretion pyelography may show a right-sided hydro-nephrosis from pressure of the cyst on the ureter.

2. A barium meal will show the duodenum and the pylorus to be pushed over to the left and the hepatic flexure of the colon at a much lower level than usual.

3. Cholecystography gives a characteristic picture of a high gall-bladder, compressed into a comma-shape by the cyst but still able to receive bile and concentrate it.

4. Calcification in the cyst wall and hepatic ducts can sometimes be made out.

Complications are mainly those due to biliary obstruction, such as suppurative cholangitis, liver abscess, and biliary cirrhosis of either hypertrophic or atrophic type. In certain instances the cyst may rupture.

A choledochus cyst may be mistaken for a hydatid cyst, a mucocele of the gall-bladder, a new growth of the liver or pancreas, pancreatic cyst, mesenteric cyst, or polycystic kidney.

Operative Treatment. If the cyst has been present for many years and there are no symptoms or attacks of jaundice and the patient is in comparatively good health, operation should not be advised, as surgical interference carries with it a high mortality. But when obstructive jaundice is present, operation should be undertaken.

The operation most commonly recommended is anastomosis of the cyst to the stomach, duodenum or jejunum. Anastomosis of the cyst to the stomach is, however, a bad operation because gastric and

duodenal contents enter the cyst and **cholangitis** often ensues after a length of time with fatal results. The cyst may be anastomosed to the duodenum, and when this is possible the results are in many respects superior to those which follow union of the cyst with the stomach. The safest internal biliary drainage operation, apart from reconstruction of the duct which is about to be described, is short-circuiting the cyst into a loop of proximal jejunum. This is performed as follows: A portion of the jejunum some 18 inches or so from the duodeno-jejunal flexure is selected and brought in front of the transverse colon to the inferior border of the cyst, and anastomosis is carried out as in the operation of gastro-jejunostomy. At the completion of this anastomosis, a jejunio-jejunostomy is performed between the proximal and distal loops of the jejunum, about 3 inches from the duodeno-jejunal flexure. The entero-anastomosis effectively deflects the intestinal chyme away from the biliary system, thus preventing the subsequent onset of an ascending cholangitis.

According to Dickson Wright, the best operation is excision of the cyst with the exception of the portion between the hepatic ducts and the lower end of the common bile duct. This gutter is reconstructed around a T-tube to form a new duct and the T-tube is then left in situ for three months or even more. By these means the affected bile tree is drained and when the T-tube is removed the bile enters the duodenum through the valve of Oddi, which prevents an ascending infection.

The operative mortality is high on account of cases being left too long before operation is undertaken after biliary obstruction has developed, and also through ignorance on the part of the surgeon of the existence of the condition and of how to tackle the surgical problem involved.

INJURIES OF THE GALL-BLADDER AND BILE DUCTS

1. **Traumatic Rupture of the Gall-Bladder and Bile Ducts.** Traumatic rupture of the gall-bladder without any associated injuries to the other abdominal organs is an exceedingly rare condition. Nevertheless, cases have been reported where the gall-bladder alone has been torn, *e.g.*, in run-over accidents, by a kick or direct blow to the right hypochondrium, in buffer accidents, or when the right lower

ribs have been crushed inward by some external violence. In stabs, gunshot wounds and other types of penetrating lesion, the liver and adjacent structures are nearly always implicated.

Subcutaneous rupture of the gall-bladder or bile passages presents a clinical picture which is quite characteristic. Following the receipt of the injury there is always a marked degree of shock, with recovery from shock within a few hours. The patient will complain that he has a constant dull pain in the right upper quadrant of the abdomen, which may be specially severe in the right costal margin. From the first to the tenth day the abdomen slowly distends with fluid, and within four to five days the tinge of jaundice will be noticed. The jaundice becomes progressively more intense, the motions become clay-coloured, the urine is laden with bile, and wasting is soon evident. By the end of the first week there is progressive loss of strength with rapidly rising pulse-rate, slight rise in temperature, and marked exhaustion. Paracentesis will disclose that there is free bile in the peritoneal cavity, and thus clinch the diagnosis.

Treatment. This should consist of exploratory laparotomy, evacuation of the bile and excision of the gall-bladder, unless the rent is situated in the fundus in which case a rubber tube may be inserted into the gall-bladder through the aperture and cholecystostomy performed. Morison's pouch should also be drained.

Rupture of the bile ducts is another rare complication of traumatism to the right upper quadrant of the abdomen. Rudberg (*München. med. Wchnschr.*, 68:1650, 1921) reviewed the subject and collected 41 cases. Recently, Lewis (*Ann. Surg.*, 108:237, 1938) found six additional cases in the literature and gave an illuminating account of a case which occurred in his own practice upon which two operations proved necessary.

The cause of the rupture of the bile passages is nearly always crushing trauma to the right hypochondriac region, and especially the right costal margin. Why the ducts should be torn without there being any associated laceration of the liver, as is the case in most of the reports, is very difficult to understand. The explanation which seems most logical to Lewis is that the force is applied in such a direction as to crush the ducts between the liver and the bodies of the vertebræ at that level. The reason for the absence of fractures of the ribs or injury to any of the hollow abdominal viscera is also dif-

difficult to explain. In a number of the reported cases the trauma resulted from the patient's being crushed between two motor-cars.

The clinical picture is identical with that of rupture of the gall-bladder without associated injuries to the liver and other viscera, *i.e.*, shock, recovery from shock, constant pain over the right costal margin, a slowly filling abdomen, the appearance of jaundice, rising temperature and pulse-rate, and the onset of toxæmia. On tapping the abdomen large quantities of bile-stained fluid are immediately withdrawn. The bile apparently remains uninfected, as suppurative peritonitis has not been reported in any case.

Access to the biliary passages is obtained through a right paramedian incision. As soon as the peritoneum is opened large quantities of bile will pour through the wound. A suction tube should be inserted into the abdominal cavity and all the pent up fluid aspirated. It will be noted that all the abdominal organs are deeply bile-stained, and that there is no evidence of localised or generalised peritonitis.

Adhesions which are glued to the gall-bladder or portal fissure should be gently separated, after which the operative field should be carefully packed off with a long strip of gauze to permit of good retraction and exposure of the gall-bladder and biliary passages.

Most of these patients are jaundiced, toxæmic and very ill, and any prolonged operation is, as a rule, out of the question. Nevertheless, a most careful search must be made for a rent in the duct. The commonest situation for the tear is high up in the common bile duct close to the junction of the right and left hepatic ducts. It is most difficult to identify and more difficult still to repair. In most instances the insertion of a cigarette drain down to the rent in the hepatic duct suffices.

Lacerations of the common bile duct are more easily dealt with, as the majority of them are situated in the anterior wall of the duct. They may be longitudinal or transverse, or again there may be a complete transverse rupture of the duct (fig. 138 [5, *a*, *b* and *c*]). Where the tear involves only the anterior wall, it is an easy matter to insert a T-tube and close the walls of the duct around the issuing limb. Where, however, the duct is completely torn across, one of two plans may be adopted. If the patient is in good condition, the ends of the duct should be picked up, freshened, and sutured together posteriorly so as to reconstruct the posterior floor of the duct. When

this has been satisfactorily accomplished a T-tube is inserted and the anterior margins of the duct are closed around this (fig. 138).

If the lower end of the common bile duct is badly lacerated or is difficult to isolate or to approximate to the upper end, it is better to

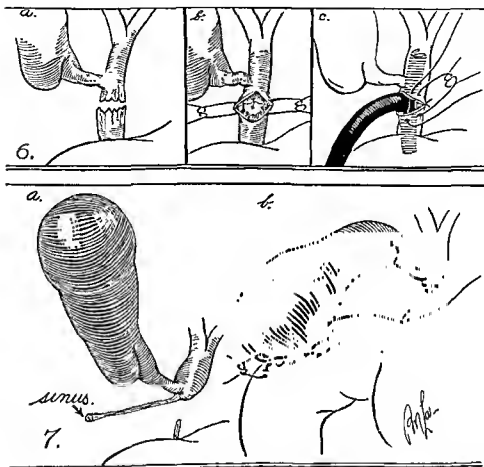


FIG. 138.—TRAUMATIC RUPTURE OF THE COMMON BILE DUCT.

6. (a), (b), and (c) shows the method of performing an end-to-end anastomosis over a T-tube.

7. (a) and (b) the common bile duct is ligatured below the cystic duct and the gall bladder is anastomosed to the duodenum.

tie the proximal end of the duct and to anastomose the gall-bladder to the stomach or duodenum, whichever seems easier (fig. 138 [7. a and b]).

In those cases where a cigarette drain has been led down to the

rent in the duct, a fistula will, of course, inevitably follow and there may be a discharge of bile for many weeks or even months following such a procedure. But in most instances the fistula eventually closes and the final result is usually quite satisfactory. In a certain proportion of cases, however, stenosis of the duct occurs and there will be intermittent attacks of jaundice with fever or the signs of complete blockage of the main duct which will necessitate further surgical intervention.

2. **Injuries to the Bile Ducts during Operation, and Post-Operative Strictures of the Common and Hepatic Ducts.** Strictures of the bile passages are commonly divided as to aetiology into four main groups:

1. Congenital strictures (see page 678).
2. Strictures caused by tumours (see page 709).
3. Inflammatory strictures due to stones or primary obliterative cholangitis (see pages 679, 684).
4. Traumatic strictures.

The fourth is the most important group and the one which concerns us now.

The commonest single cause of a traumatic stricture of the main bile duct is cholecystectomy. In Waltman Walters' series (*Proc. Staff Meet. Mayo Clinic*, 12:25, 1937) of 51 cases of stricture of the common duct, 48 followed excision of the gall-bladder. Gray writes:

The distressing features of this condition may be emphasised when it is considered that of 228 patients with stricture of the extra-hepatic bile ducts who were operated on at the Mayo Clinic in the 20-year period from 1917-1936 inclusive, 175 (76.7%) were women. Seventy-three (32.0%) of the total number of patients with stricture were in the fourth decade and 64 (28.1%) in the third decade of life. Eighteen (7.9%) were less than 30 years of age. In other words, of 10 patients with stricture of the extra-hepatic bile ducts, 7 will be less than 50 years of age. Practically all of the patients in whom stricture occurred had been operated on previously for diseases of the biliary tract.¹

It is often stated that abnormalities in the course, length and termination of the cystic duct and variations in the course, origin and distribution of the cystic artery are important predisposing causes; but it is the surgeon's duty to be familiar with these variations and to recognise them at operation whenever they are present. He should work by sight and not by faith. During the performance of a chole-

¹ Gray, *Am. J. Surg.*, 40 217, 1938.

cystectomy it should be a rule that the three ducts—the cystic, the common hepatic and the common bile duct—be displayed and the cystic artery clearly identified before being ligatured and the cystic duct severed. Success in the surgery of the gall-bladder and bile passages depends largely upon good exposure, good anæsthesia, a well-illuminated operative field and meticulous care during the dissection of the parts to be displayed.

When access proves difficult or the parts concerned in the operation have not been clearly visualised, excision of the gall-bladder is always a hazardous undertaking. One of the commonest causes of injury to the common hepatic duct is hæmorrhage occurring from the cystic artery or the right hepatic artery during a dissection which aims at displaying the cystic duct and the cystic artery itself. In clearing the fatty tissue away from the neck of the gall-bladder the artery may be torn by dissecting forceps (fig. 139 [3 a]). The artery may snap and retract under the common hepatic duct where it is free to bleed copiously in its hidden retreat if the clamped and divided cystic duct is drawn too forcibly upward in an endeavour to simplify the freeing of the undersurface of the organ from its bed in the liver. It may, too, when picked up with artery forceps, slip through its wide and clumsy blades or it may be avulsed when the hæmostat which grasps it is used as a retractor by a thoughtless assistant. Artery forceps with their sharp serrations may actually bite through the artery and thus produce a troublesome hæmorrhage.

The cystic or even the right hepatic artery may be torn when the peritoneum overlying the anterior surface of the ducts is being drawn aside to display the structures in the vicinity of the cystic duct. The hæmorrhage is always brisk, and blood soon floods the area of operation, obscuring everything. The surgeon in his excitement and hurry to arrest the bleeding makes a blind grab with a hæmostat for the bleeding point, and the jaws of the instrument may crush an appreciable portion of the duct in securing the vessel. If a ligature is applied as in figure 139 (3 b), a considerable portion of the circumference of the duct will be included, and blood clot obscuring all traces of the tragedy may prevent the mishap from being realised at the time of its occurrence.

When hæmorrhage from the cystic artery or the right hepatic artery occurs during the performance of a cholecystectomy it is an

easy matter to control the bleeding and to visualise the culpable artery by compressing all the structures in the free margin of the gastrohepatic omentum with the fingers. The surgeon should intro-

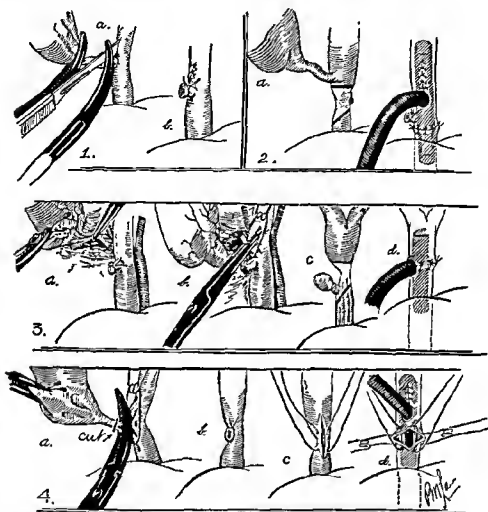


FIG. 139.—INJURIES OF THE BILE DUCTS DURING CHOLECYSTECTOMY AND THE METHODS OF DEALING WITH THE STRICTURES WHICH RESULT THEREFROM.

2. (a) shows a stricture produced by a stone which is ulcerating through the common duct and the method of dealing with such a stricture.

duce the index finger of his left hand into the foramen of Winslow and compress the common hepatic artery between this finger and the thumb. The bleeding point is then seized and carefully ligatured, after which the pressure is released.

There would appear to be no excuse for incising the common hepatic duct while dividing the cystic duct between two curved hæmostats, as depicted in figure 139 (1 a), yet such an accident has been known to happen. If the incision in the common hepatic duct is noticed at the time of the operation, as it often will be since bile will be seen issuing from the rent, it is a simple matter to close the opening with a few interrupted sutures (fig. 139 [1 b]). A cigarette drain is then led down to the region of the stump of the cystic duct. In many cases, too, where the accident remains undetected, the incision in the duct will close after a few days provided a drainage tube has been inserted at the completion of the operation. If, however, drainage has been omitted, the abdomen will distend with bile, jaundice will develop in the course of a week or ten days, and all the signs of toxæmia will be in evidence. At a secondary operation the opening in the duct should be closed, or if this is not feasible a Penrose drain should be led down to the site where bile is seen to be issuing from the duct.

In examining the records of many cases of strictures of the bile duct which have followed operative procedures upon the biliary passages and gall-bladder, I have been struck by two things: While hæmorrhage has accounted for most of the accidents, it would appear that over-confidence has been the cause of not a few. In the "over confidence" group a gall-bladder has been unduly mobile and the operation has, to all intents and appearances, been one of great simplicity in a thin and visceroptotic patient.

Figure 139 (4 a) illustrates how in firmly retracting an unduly mobile gall-bladder a clamp is applied too close to the junction of the cystic duct with the common ducts; in fact, the clamp may even grasp a portion of the common duct and when the ligature is tightened it drags up an even greater portion of the duct, thus producing partial stricture (fig. 139 [4 b]).

The cystic duct should never be ligatured flush with the common duct, but should rather be tied about a quarter of an inch away from its junction with the two main ducts, and to ensure a nice accuracy in the application of the ligature an aneurysm needle threaded with silk should be used instead of a hæmostat.

An incomplete stricture, as is shown in figure 139 (4 b), may exist for many years without producing any untoward symptoms; but once

scar tissue is laid down this slowly contracts, and sooner or later a low-grade cholangitis sets in with the result that the narrow channel eventually becomes blocked with mucopus, and with this is associated intermittent fever, chills and jaundice.

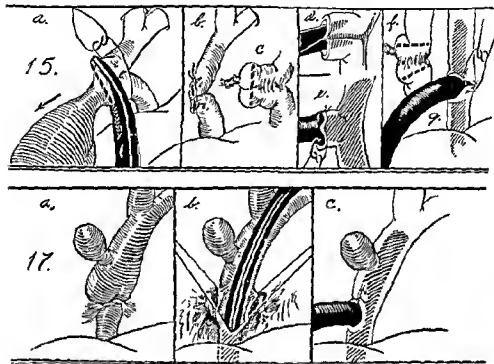


FIG. 140—INJURIES OF THE BILE DUCTS DURING CHOLECYSTECTOMY, AND THE METHODS OF DEALING WITH THE STRICTURES WHICH RESULT THEREFROM.

15 (a) depicts how in retrograde cholecystectomy the common hepatic and common bile ducts may be ligatured.

15 (b) shows the appearances after the ducts have been ligatured.

15 (c) shows the operative findings.

15 (d) and (e) indicate the method of reconstruction. An alternate method is shown in 15 (f) and (g).

17 shows obstruction of the common bile duct by a fibrous band following cholecystectomy.

17 (b), the common bile duct is being probed.

17 (c), the common bile duct is being drained by means of a T-tube

Figure 139 (4 c and d) indicates the steps in the repair of such an incomplete stricture.

Figure 140 (15 a) shows how during a retrograde cholecystectomy, i.e., commencing the dissection of the gall-bladder from the fundus end rather than from the cystic duct end, firm traction upon the

gall-bladder may angulate and approximate the two common ducts, with the result that forceps may inadvertently be applied in such a way as to embrace both main ducts instead of the taut and attenuated cystic duct. Kehr was the first to draw attention to the mechanics of this accident. If the gall-bladder is examined after it has been excised, the cystic duct can be traced into the tell-tale segment of the main duct. This finding should lead the surgeon to examine the common ducts and remove the suture which ties them together. It is an easy matter at this stage to perform an end-to-end anastomosis between the cut ends of the duct, as shown in figure 140 (15 g). It is advisable to leave the T-tube in position for at least three weeks following such an accident.

Stricture of the common bile duct may be caused by approximating the edges of the peritoneum over the duct too tightly at the completion of a well-conducted cholecystectomy or cholecystectomy combined with choledochostomy.

Figure 140 (17 a) illustrates the operative findings in such a case. The stricture in this instance was caused by dense fibrous tissue which compressed the duct from without, and when this band was divided the walls of the duct expanded almost to full capacity. It is a wise plan in such cases to open the common duct and explore for stones and to test the patency of the papilla, external drainage by means of a T-tube being indicated to drain the biliary tree, as cholangitis is often present with such strictures (fig. 140 [17 b and c]).

It is difficult to account for some cases in which there has been no injury to the ducts and cholecystectomy has been conducted successfully but in which at a second operation a cartilaginous mass of scar tissue is found somewhere along the course of the main duct, compressing it at one point and giving rise to partial stricture. It is possible that the peritoneal scarring may be due to an organising hæmatoma or perhaps to a circumscribed patch of localised chronic peritonitis at the margins of the gastrohepatic omentum. Such peritonitis may have been lighted up by contamination of the operative field at the time of the original cholecystectomy or by leakage around the T-tube which had been implanted in the common duct.

The common bile duct may also be injured during gastro-duodenal resections for extensive cancers of the pylorus and for deeply penetrating chronic duodenal ulcers.

Signs and Symptoms. Following operative injuries to the extra-hepatic bile passages, the symptoms and signs are found to vary considerably in individual cases, but actually there are three well-defined groups:

In the first, the patient makes an uninterrupted recovery and all appears to be progressing satisfactorily for many months or even years. Then cholangitis ensues and with this is associated recurrent attacks of mild jaundice. This history would suggest an incomplete type of stricture.

In the second group, the patient has a stormy convalescence and there is a persistent discharge of bile through the wound. This leads to rapid emaciation and digestive disturbances. There are also loss of appetite and loss of spirit, two well-known accompaniments of loss of bile.

In the third group, the signs and symptoms are those of obstruction of the common bile duct. Pain is slight, but when present it is confined to the right upper quadrant of the abdomen. There is a mild persistent fluctuating jaundice, and the intermittent hepatic fever of Charcot is in evidence. With this is associated pylorospasm, gastric flatulence, occasional bouts of vomiting and cramp-like sensations in the epigastrium. After a few weeks the jaundice deepens and the skin becomes tinted a dark yellowish-green.

The diagnosis is based on the history of a previous operation at which cholecystectomy was performed with difficulty or with the obscuring of the operative field by considerable bleeding. Jaundice arising after cholecystectomy may be due to a stone which is impacted in the common bile duct or to some injury to the duct which has led to a stricture. A persistent biliary fistula after cholecystectomy at once suggests some damage to the common bile duct, while a persistent fistula following excision of the gall-bladder and choledochostomy would indicate that a stone is impacted in the ampulla of Vater or that the lower reaches of the duct are silted up with biliary mud.

Treatment. These operations of re-formation of the common duct are among the most difficult tasks in surgery. "To obtain the best results all the highest qualities of the surgeon may be called into play: courage, resource, patience, accuracy and rapidity of judgment, the finest craftsmanship, and a tranquility of mind that nothing can disturb" (Moynihan).

The commonest cause of death following secondary operations upon the bile passages is due to post-operative cholæmic hæmorrhage, and the best method of combating impairment of liver function is the intravenous administration of repeated small doses of whole blood.

The simplest methods of restoration of the biliary intestinal continuity are those in which the gall-bladder remains and the stricture is distal to the point of entrance of the cystic duct into the common duct. Figure 138 (7) illustrates such a case treated by cholecystoduodenostomy. However, when contemplating reconstructive operations the surgeon has to bear in mind that in the majority of cases the gall-bladder is absent and that the final issue often depends upon many factors which include: (1) the extent of the trauma to the bile passages; (2) the degree of cholangitis present; (3) the presence or absence of cirrhosis of the liver; (4) the presence or absence of jaundice; (5) the general condition of the patient; (6) the skill of the surgeon and his experience in this type of surgery.

The best results are obtained when there is a partial obstruction present, when after excision of the stricture a direct end-to-end anastomosis of the two ends of the ducts is feasible, when the common hepatic or bile duct can be anastomosed to the duodenum without any tension, when operation can be carried out early in the course of the biliary obstruction before the liver has been injured by cirrhosis or infection, and when adequate measures have been adopted to render the patient as fit as possible to withstand operation.

No one operation can be employed for all cases, and each case must be considered individually according to the situation and extent of the lesion.

Reconstructive Operations upon the Bile Duct. 1. Dilatation of the stricture of the duct followed by T-tube drainage.

2. Longitudinal division of the stricture of the duct followed by repair by:

(a) The Heineke-Mikulicz method.

(b) Insertion of a buried rubber tube and suture of the duct around this.

3. Excision of the stricture followed by anastomosis of the distal and proximal cut ends of the ducts—choledocho-choledochostomy.

4. Anastomosis of the end of the common bile duct or common

hepatic duct with the stomach, duodenum or jejunum—direct cholecysto- or hepatico-enterostomy.

5. Restoration of the biliary intestinal continuity with the aid of rubber tubes when owing to the shortness of the remaining stump of the hepatic duct it is impossible to make a direct anastomosis between the end of the duct and the intestine—indirect hepatico-enterostomy.

6. Implantation of an external biliary fistula into the duodenum or jejunum.

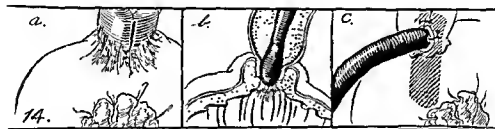


FIG. 141.—STRICTURE OCCURRING AFTER HEPATICO-DUODENOSTOMY.

At operation the common hepatic duct was incised, the stricture dilated, and T-tube drainage instituted.

7. Hepato-enterostomy, i.e., the anastomosis of the denuded liver tissue to the duodenum or proximal jejunum where the stricture involves the right and left hepatic ducts within the liver.

Dilatation of the Stricture. In certain cases incision of the duct to permit of dilatation of the stricture by means of graduated sounds or bougies is a wise procedure. Figure 140 (17 a, b and c) illustrates a case in which dilatation of the stricture followed by T-tube drainage was instituted with success, while figure 141 (14 a, b and c) shows a stricture occurring after hepatico-duodenostomy. The T-tube in this instance was left in situ for nine months and when it was removed there was no external discharge of bile.

Cholecysto-Choledochostomy. Where it is possible to establish direct continuity of the bile passages by end-to-end anastomosis, this should be the method of choice.

Figure 142 depicts W. J. Mayo's operation of reconstruction by end-to-end anastomosis.

In some cases following cholecystectomy where a segment of the central portion of the common duct has been excised, at the secondary

operation both ends of the duct may, after careful dissection, be displayed, and if after mobilising the duodenum they can be approximated without any tension, an end-to-end union should be carried out. The ends of the duct are fashioned, as in figure 142 (5 a), after which the posterior margins of each end of the duct are approximated with a few interrupted sutures. The upper limb of the T-tube is inserted into the hepatic duct, while the lower limb is led down into the common duct, after which the anterior margins of the ducts are approximated snugly around the long issuing limb of the T-tube (fig. 142 [5 c]).

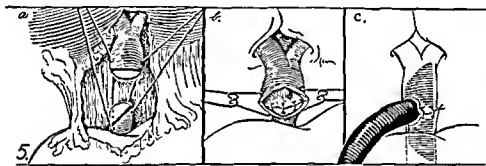


FIG. 142.—CHOLEDOCHAL CHOLEDOCHOSTOMY—W. J. MAYO'S OPERATION OF RECONSTRUCTION BY END-TO-END ANASTOMOSIS.

Figure 139 (2 a) illustrates a case of stricture of the common bile duct due to a calculus which had perforated the wall of the duct. In this case, as the gall-bladder contained stones and was quite useless for anastomosis with the intestine, it was excised and following this the strictured portion of the duct was removed and end-to-end anastomosis performed. At the completion of this operation a T-tube was inserted through a separate incision in the common hepatic duct, one limb of the tube passing upward toward the liver, the other being led downward into the common duct well beyond the new junction. This is an excellent method of performing choledochal-choledochostomy, as the tube not only effectually drains the biliary passages and prevents stricture formation at the site of the anastomosis, but when it is removed it does not in any way damage the sutured area in the duct.

Figure 139 (3 c and d) illustrates a case of stricture of the common

bile duct in which the stricture was excised and end-to-end anastomosis performed around the T-tube.

Eliot (1936), who analysed 38 cases of choledocho-choledochostomy, found that 14 were well ten to nineteen years afterward, while ten were in good health five to ten years afterward.

Longitudinal Division of the Stricture of the Duct Followed by the Heineke-Mikulicz Method of Repair. Figure 139 (4 c and d) shows the essential steps of this method.

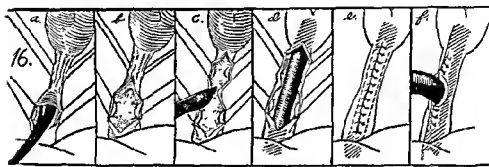


FIG. 143.—LONGITUDINAL STRICTURE OF THE COMMON BILE DUCT FOLLOWING CHOLECYSTECTOMY.

(a), (b), (c), (d) and (e) show the method of dealing with such a stricture by means of an indwelling tube.

(f), T-tube drainage as an alternative method.

In cases of "longitudinal" stricture, as in figure 143 (16 a), where it would be very difficult or impossible to anastomose the bulbous end of the shortened hepatic duct to the duodenum, the stricture may be divided in a longitudinal manner and a small rubber tube laid into the trough which has been displayed. One edge of the tube should rest in the common hepatic duct, while the other end should be below in the common bile duct.

Following such a repair of the bile duct Fardman removed a tube which had been in the common duct for five and a half years. In Judd's case the tube was in situ for six years; while in Lahey's case at a third operation he removed a tube which had been in the common duct for seven years, and after thoroughly irrigating the bile passages he inserted another tube and closed the margins of the ducts around this.

It appears to me that a T-tube possesses many advantages over the

buried tube (fig. 143 [16 f]), as this obviates the necessity for another operation for the removal of the tube.

Anastomosis of the End of the Common Bile Duct or Common Hepatic Duct with the Stomach, Duodenum or Jejunum—Direct Choledoch- or Hepatico-Enterostomy. It is generally agreed that if the lower portion of the common bile duct or hepatic duct can be implanted satisfactorily and without tension into the intestine, this should be the method of choice. Choledoch-gastrostomy should be avoided, as vigorous peristaltic movements of the stomach might cause the suture line to tear away and thus give rise to leakage and peritonitis.

In most cases the first portion of the duodenum is selected for anastomosis with the duct—choledoch- or hepatico-duodenostomy, but where the duodenum is firmly encased in scar tissue and is otherwise inaccessible, the proximal jejunum may be employed with good effect for the anastomosis.

Perhaps one of the simplest methods of implanting the stump of the common bile duct or hepatic duct into the duodenum is illustrated in figure 144. The duct is freed and its bulbous end cut across, a rubber tube is inserted into the duct, and this is stitched in place. A small opening is then made in the antero-superior wall of the duodenum at the point at which the duct is to be implanted. This opening in the duodenum is surrounded by a purse-string suture, the duct is passed into the duodenum and the purse-string suture is firmly tied. The tying of this suture cannot appreciably constrict the duct owing to the presence of the indwelling rubber tube. A few sutures between the duct and the duodenum complete the junction, after which a portion of adjacent omentum is drawn over the sutured area for added protection.

By a second plan an end-to-side anastomosis between the end of the duct and adjacent duodenum is carried out as depicted in figure 145.

Le Grand Guerry (*Ann. Surg.*, 102:780, 1935) performed eight hepatico-duodenostomies with excellent results in each. Eliot (*Ann. Surg.*, 101:668, 1936) states that he was able to collect from the literature 41 cases of choledoch-duodenostomy and 11 of these patients were in good health ten to twenty years after the operation.

Walton's operation (*Surg., Gynec. & Obst.*, 21:269, 1915) is an

ingenious plastic hepatico-duodenostomy. The steps of this operation will be readily appreciated by reference to figure 145 (9).

The essential steps of Moynihan's method are depicted in figure 145 (10 a and b).

In those cases where the duodenum is firmly bound down to the underlying structures or is friable from inflammation, it may be impossible to mobilise it or to utilise it for purposes of anastomosis. In such cases the duct should be implanted into the jejunum by the methods suggested by von Mikulicz, Maragliano and Monprofit in 1908.



FIG. 144.—CHOLEDOCHO-DUODENOSTOMY.

The duct is freed, and its bulbous end cut across. A rubber tube is inserted into the duct and this is stitched into place. The end of the duct is then implanted into the duodenum in the manner shown in (b), (c) and (d).

A loop of jejunum from 18 to 20 inches from the duodeno-jejunal flexure is brought across the transverse colon and anchored in the region of the hilum of the liver in such a manner that no kinking of the jejunum results. A rubber tube is then stitched to the trimmed cut end of the hepatic duct and led through a small opening in the adjacent anterior wall of the jejunum. The opening in the jejunum is then stitched around the stump of the hepatic duct which is invaginated into the lumen of the gut. The operation is completed by performing an entero-anastomosis between the proximal and distal loops of the jejunum. This anastomosis eventually deflects the gastric and intestinal contents away from the hepatico-enterostomy and thus diminishes the chances of cholangitis (fig. 146).

Perhaps a better method is depicted in figure 146 (13). 1 per-

formed this operation of hepatico-jejunostomy in one case with complete success eight years ago.

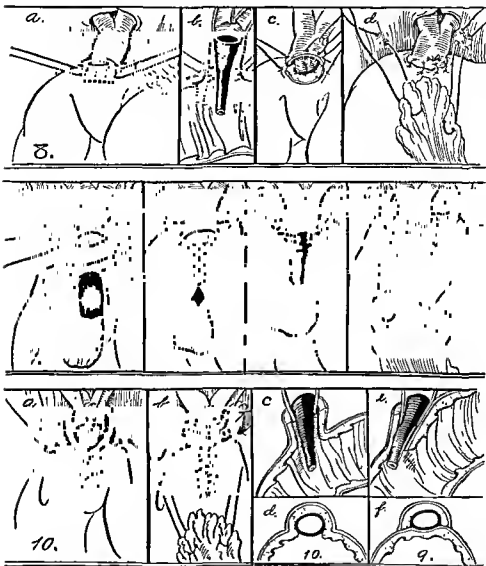


FIG. 145.—CHOLEDOCHO-DUODENOSTOMY.

(8) End-to-side anastomosis with the aid of a rubber tube.

(9) The various steps of Walton's operation.

(10) Moynihan's modification of Walton's method.

Indirect Hepatico-Duodenostomy—Sullivan's Operation. Where the stump of the hepatic duct is very short or lies embedded in the portal fissure, it may be impossible to perform a direct anastomosis

between the end of the duct and the intestine. When therefore the divided end of the duct and intestine cannot be properly approximated, the resulting gap may be bridged by the insertion of a rubber tube which is then invested with omentum.

Sullivan described this method (*J. Am. M. Ass.*, 53:774, 1909; and 58:206, 1912) and states that there is some evidence to show that the granulation tissue encircling the tube becomes lined by the extension above and below of the normal epithelium of the duct and intestine.

Couch (*Brit. J. Surg.*, 24:130, 1936) adopted a modification of Sullivan's method in a very complicated case. He used a modified T-tube which was left in situ for many months. Couch states that

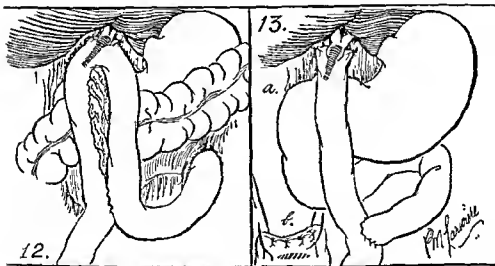


FIG. 146.—CHOLEDOCHO- OR HEPATICO-JEJUNOSTOMY.

(12) A loop of proximal jejunum is drawn across the transverse colon and its apex is sutured beneath the stump of the bile duct. Lateral anastomosis is performed and an end-to-side choledocho- or hepatico-jejunostomy is carried out in the manner depicted.

(13) Choledocho- or hepatico-jejunostomy by the method in Y.

the purpose of the tube is not merely to act as a mould about which the duct may be fitted, but rather to mould the growth and repair the efforts of nature so that there may be a patent channel from the liver to the duodenum.

Implantation of an External Biliary Fistula into the Duodenum or Jejunum. The first successful transplantation of an external biliary

fistula into the duodenum was performed by Hugh Williams at the Massachusetts Hospital, Boston, in 1914. His patient is still alive and well. Successful cases have been reported by Williams and Smithwick (*Ann. Surg.*, 89:942, 1929), Lahey (*Ann. Surg.*, 77:767, 1923; and 105:760, 1937), Lillianthal (*Ann. Surg.*, 77:865, 1923), and Waltman Walters (*Proc. Staff Meet. Mayo Clinic*, 4:77, 1929; and *Surg., Gynec. & Obst.*, 48:305, 1929). Eliot records that there have been some 41 cases of fistula transplantation, 29 of these being performed in America. On eighteen occasions the fistula was implanted into the stomach, in one case into the jejunum, and in the remainder into the duodenum. Lahey has performed this operation in 14 cases, but in only 2 cases was relief permanent. He attributes the failures to the tract contracting and to re-obstruction of its lumen with inflammatory debris or biliary sand.

In cases where an external biliary fistula has followed upon a very high division or what practically amounts to a complete ablation of the common hepatic duct, making anastomosis between the hepatic duct and the duodenum, or even the jejunum, impossible, the fistula should be freed from the skin and from its surroundings as far as the hilum of the liver and implanted directly into the duodenum or jejunum (fig. 147 [19]).

If the fistula is lined with mucous membrane and an anastomosis with the duodenum is performed, the final results should, on the whole be satisfactory; but if, on the other hand, the tract is not lined with mucosa it will in all probability contract, leading to the formation of a stricture.

Where the common ducts have been accidentally removed at operation and the patient has survived, either an external biliary fistula or jaundice will develop. In the latter case an external biliary fistula should be established, which can later be coned out and transplanted into the duodenum.

When transplantation of an external biliary fistula is performed it must, of course, adequately drain the intra-hepatic ducts and these ducts must be free of stones, otherwise obstruction will recur.

Figure 147 (18) illustrates a case of Lahey's in which the fistula was coned out and implanted into the stomach while the stump of the cystic duct—almost a miniature gall-bladder—was anastomosed to the duodenum.

This operation was completed by performing a gastro-jejunostomy, as Lahey thought that some obstruction of the outlet to the stomach might follow the double implantation. This patient made a very good recovery.



FIG. 147.—IMPLANTATION OF AN EXTERNAL BILIARY FISTULA INTO THE DUODENUM.

Two alternative methods are depicted.

Operation for the Establishment of a Direct Communication Between the Parenchyma of the Liver and the Alimentary Tract—Hepato-Enterostomy. In Kehr's operation the liver is exposed and from a convenient portion of the lower margin of the right lobe a strip of liver tissue about $2\frac{1}{2}$ inches in length and about 1 inch wide is excised. Then, with the thermo-cautery a hole is burned into the substance to such a depth that several moderate-sized bile ducts are opened. The edges of the liver may be anastomosed to the stomach—hepato-gastrostomy, to the jejunum—hepato-jejunostomy, or prefer-

RESULTS OF TREATMENT

END RESULTS OF 80 OPERATIONS PERFORMED FOR STRICTURE OF THE COMMON BILE DUCT²

Operation	Total	Patients Well when Last Heard from	Recurrent Attacks of Pain and Jaundice Patients	Patients Who Died after Leaving the Clinic, and Causes of Death	Patients who Died in Hospital after Operation, and Causes of Death
Choledochoduodenostomy . .	27	21	3	2 { 1 bronchopneumonia 1 hemorrhage	1 pneumonia, cardiac, hepatic insufficiency
Hepaticoduodenostomy	22	12	2	6 { 3 hepatic insufficiency 2 hemorrhage 1 pneumonia	2 hepatic insufficiency
Cholecystoduodenostomy	1			1 hemorrhage	
Cholecystogastrotomy	1	1			
Hepaticogastrotomy	2				2 hemorrhage
Plastic reconstruction of bile ducts	12	7	1	3 { 2 hepatic insufficiency 1 unknown	1 hemorrhage
Transplantation of external biliary fistula	7	2	2	2 { 1 hepatic insufficiency 1 unknown	1 hemorrhage
Establishment of external fistula	8	2 (Both spontaneous biliary fistula to duodenum)	2	1 hemorrhage	3 hepatic insufficiency
Total	80	45 (56%)	10 (12.5%)	15 (19%)	10 (12.5%)

ably to the duodenum—hepato-duodenostomy. The duodenum is mobilised and brought alongside the opening in the liver, after which an incision is made in the anterior wall of the duodenum, 2 to 2½ inches in length, and the margins of the duodenum are sutured to the margins of the aperture in the liver.

² Walman Walters, *Surg. Clin. N. Am.*, 1915, 1939 Courtesy of W. R. Saunders Co

This operation rarely succeeds but may be indicated where at operation the hepatic ducts cannot be visualised or where as the result of primary obliterative cholangitis the ducts are reduced to a fibrous cord.

Primary obliterative cholangitis is not due to trauma or to stone but to an extensive infection and extreme fibrosis uniformly distributed throughout the wall of the duct. Interesting cases have been reported by Miller (*Tr. Am. Surg. Ass.*, 45:122, 1927) and by Judd (*Ann. Surg.*, 84:404, 1926).

Post-Operative Complications. These may be summarised as follows: hæmorrhage, shock, peritonitis, pancreatitis, subphrenic abscess, suppurative cholangitis, liver death—cholæmia, septic thrombosis of the portal radicles, and pneumonia. By far the commonest cause of death following these reconstructive operations is cholæmia.

CHAPTER 2

CARCINOMA OF THE GALL-BLADDER AND OF THE BILE DUCTS

CARCINOMA OF THE GALL-BLADDER

Carcinoma of the gall-bladder is a commoner disease than it is generally estimated to be. Mohardt (*Surg., Gynec. & Obst.*, 69:440, 1939) in a collective review states that the exact incidence of primary carcinoma of the gall-bladder is difficult to determine. Shelley and Ross (*Arch. Surg.*, 25:65, 1932) gave the condition fifth place in frequency of incidence of cancer among the organs of digestion, while Boyce and McFetridge (*Internat. Surg. Digest*, 21:67, 1936) gave it sixth place. The order of incidence is as follows: (1) stomach; (2) colon; (3) rectum; (4) œsophagus; (5) gall-bladder and ducts. In Jankelson's series (*New England J. Med.*, 217:85, 1937) of 11,400 consecutive autopsies it was found 31 times, an incidence of 0.27 per cent. Illingworth (*Brit. J. Surg.*, 23:4, 1935) states that in the post-mortem department of the Edinburgh Royal Infirmary during the last sixteen years there have been 36 cases of carcinoma of the gall-bladder in a total of 8,490 autopsies, and that during the same period the cases of malignant disease of all types and of all parts of the body numbered 1,275.

Surgical experience shows that cancer is found in from 1 to 2.5 per cent of all operations upon the gall-bladder and bile passages. Wilkie (*Brit. Encycl. Med. Pract.*, 5:488, 1937) in 1,100 operations upon the gall-bladder and bile ducts observed it in 40 cases. Deaver (*Med. Rec.*, 96:47, 1919) found 16 cases in 1,000 operations upon the gall-bladder. Smithies (*Am. J. M. Sc.*, 157, 67, 1919) reported 23 cases in 1,000 similar operations, while Judd and Gray (*Surg., Gynec. & Obst.*, 55:308, 1932) recorded 212 cases from 22,365 operations performed upon the gall-bladder and bile passages.

All the reported series show that malignant disease of the gall-bladder is about three to four times more common in women than in men and that it is more frequently seen after the age of 50, although

cases occurring in younger patients have been recorded from time to time.

Ætiology. There are two important ætiological factors: Simple papilloma and calculous cholecystitis.

Innocent papillomata are commonly found in the gall-bladder (figs. 148 and 149). They may be single or multiple and occur as small bile-stained warty growths projecting from the mucous mem-



FIG. 148.—CHOLECYSTOGRAM SHOWING TWO SMALL PAPILLOMATA OF THE GALL-BLADDER.

This diagnosis was confirmed at operation (Bull).

brane. Illingworth considers that it is highly improbable that these innocent lesions bear any significant relationship to carcinoma. Phillips (*Am. J. Surg.*, 21:38, 1933) reported a series of 500 cases of papilloma of the gall-bladder with no single instance of cancerous transformation. There are, nevertheless, very rare instances in which multiple papillomata appear to form an intermediary link between the simple growth and the papillary type of cancer of the gall-bladder.

It is generally agreed that there is a very definite relationship between the incidence of *calculous cholecystitis* and cancer of the gall-bladder, and in approximately 80 per cent of cases of cancer of this organ gall-stones are found to be present. It is held by some authorities that cholecystitis of itself is an even more important ætiological

factor than a constant irritation produced by gall-stones. Lentz (*Beitr. z. klin. Chir.*, 137:38, 1936) in 557 cases of gall-stones found that malignancy developed in 5.1 per cent of women over 39 years of age

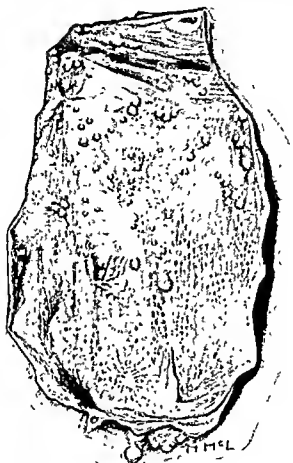


FIG. 119.—MULTIPLE PAPILLOMATA OF THE GALL-BLADDER.

The growths are of benign type, but in places show early invasion of the muscle coat. The condition may be regarded as pre cancerous. (By courtesy of Mr. C. F. W. Illingworth and the *British Journal of Surgery*.)

and in 4.3 per cent of both sexes. Moynihan found the incidence of malignancy following cholelithiasis to be 5 per cent, Riedel 8 per cent, Graham 8 per cent and Schroeder 14 per cent.

Whilst it is probable that these figures, derived as they are from selected groups of cases—namely, those in which the symptoms were sufficiently severe



FIG. 150.—SCIRRHOUS CARCINOMA OF THE GALL-BLADDER.

At operation the solitary stone was found impacted near the neck of the gall-bladder. The viscus was acutely inflamed and contained mucopus. (By courtesy of Mr. C. F. W. Illingworth and the *British Journal of Surgery*.)



FIG. 151.—SCIRRHOUS CARCINOMA OF THE GALL-BLADDER, GIVING RISE TO HOUR-GLASS DEFORMITY.

The great omentum is adherent to the fundus of the distal sac which is obstructed and inflamed. (By courtesy of Mr. G. F. W. Illingworth and the *British Journal of Surgery*.)

to necessitate admission to hospital—tend to give a somewhat exaggerated idea of the frequency of malignant degeneration, they nevertheless indicate that the risk is by no means inconsiderable. From the clinical standpoint it is important that this risk should be fully appreciated. When a carcinoma of the gall-bladder is fully established, there is little prospect of being able to extirpate it completely. Our aim must therefore be to prevent its occurrence, and this can only be achieved by early operation. And since a carcinoma may arise even after removal of the stones the only certain method of prevention is by the performance of cholecystectomy.¹

Pathology. There are four types of carcinoma of the gall-bladder:

1. Scirrhus carcinoma.
2. Papillary carcinoma.
3. Mucoid or colloid carcinoma.
4. Squamous-cell carcinoma or epithelioma.

The *scirrhus* infiltrating type is the commonest. It commences in the submucous coat as an indurated nodule or as a diffuse infiltration of the walls of a chronically inflamed gall-bladder (figs. 150 and 151). It is difficult at exploratory operation to distinguish between this invasive type of growth and a gall-bladder which is the seat of chronic sclerosing inflammatory changes. The walls of the gall-bladder are thick, hard, contracted and pearly white in colour. When the growth arises in the region of the neck of the gall-bladder it may produce a mucocele or even an empyema, and when it involves the body an hour-glass effect may result.

The growth quickly spreads into the liver and metastasises to the cystic lymph gland and to the nodes along the main bile ducts (fig. 152). Microscopically it is an adenocarcinoma.

The *papillary* cancer is a comparatively rare type (figs. 153 and 154). There may be multiple cauliflower-like growths choking the lumen of the organ, or there may be a solitary narrow stalk. The tumour is very vascular and is prone to bleed or to undergo necrotic changes. It may plug the neck of the gall-bladder and give rise to an empyema or it may spread delicate tentacles of growth along the bile passages and thus obstruct this vital channel.

On section this columnar-celled adenocarcinoma often presents a definite papillary arrangement.

When the gall-bladder becomes infiltrated with jelly-like *mucoid*

¹ Ullingworth, *Brit. J. Surg.*, 23:4, 1935.

or *colloid* cancer, it has a bloated appearance. The growth is eager in its course and swiftly implants itself in the liver and regional nodes, and far and wide throughout the peritoneal cavity.

Epithelioma of the gall-bladder is a pathological freak and its existence is most difficult to explain. It is conceivable, however, that

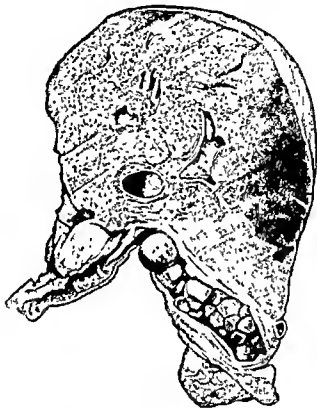


FIG. 152.—SCIRRHIOUS CARCINOMA COMPLETELY ENVELOPING THE GALL-BLADDER AND INVADING THE LIVER.

The adherent omentum is infiltrated by the growth and a secondary nodule is seen in the cystic lymph gland. (By courtesy of Mr. C. F. W. Illingworth and the *British Journal of Surgery*.)

the cylindrical cells of the mucous membrane as a result of the same unknown stimulus may undergo metaplasia and revert to primitive form. It is highly malignant and copies the infiltrating scirrhus type in its mode of dissemination.

Cancer of the gall-bladder remains locally malignant for a short space of time. Invasion of the liver by direct spread soon occurs and a

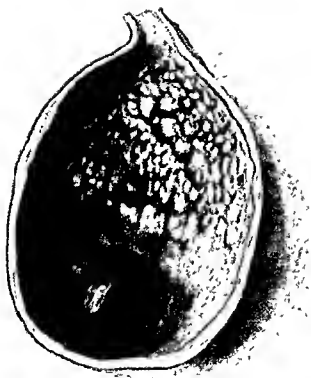


FIG. 153.—AN EARLY CARCINOMA OF THE GALL-BLADDER OF THE PAPILLARY TYPE.

At operation the large stone was found to be impacted at the neck of the gall-bladder in close contact with the growth. (By courtesy of Mr. C. F. W. Illingworth and the *British Journal of Surgery*.)

hard, greyish-white plaque, which is confluent with the gall-bladder, results, while at a later stage umbilicated metastatic nodules become scattered throughout the liver substance. It is not long before the hepatic flexure of the colon, the great omentum, the duodenum and the pyloric segment of the stomach become welded in a solid rock-like mass to the gall-bladder.

The glands along the free edge of the gastrohepatic omentum and in the deep recesses of the portal fissure become involved with growth at an early stage and compress the bile ducts giving rise to a deepening jaundice. Seedlings of growth in the peritoneum—malignant ascites—is the terminal phase. Distant metastases are uncommon, even in advanced cases, but dissemination to the lungs occurs in about 10 per cent of the cases.

Clinical Features. It is often very difficult, or even impossible, to make a correct pre-operative diagnosis, as in one group of patients the clinical manifestations are indistinguishable from those of calculous cholecystitis, while in another group the presenting features and symptoms are those of malignancy and not those of disease of the biliary tract.

In the first group, which Lancereaux termed the *biliary* and which constitutes fully 50 per cent of the cases, a definite history of chronic cholecystitis, perhaps dating back for many years, can be obtained. With the onset of cancer, pain, which at first may not be severe, is constant and unremitting. It is felt as a dull ache or gnawing beneath the right border of the costal margin and at the back below the tip of the scapula. At times, nevertheless, the pain may be cramp-like and intense, and resemble true biliary colic. In a minority of patients pain is significantly absent. There is epigastric distress and flatulent distension, intractable nausea, and distaste for food, and occasionally bouts of vomiting which bring no relief. Slight shivering attacks associated with low fever usher in the jaundice which at first is mild in character; but it is exceptional for the yellow tinge to depart. It usually persists and increases in intensity until the whole body is deeply dyed with bile pigments. The intensity and the persistence of the jaundice should arouse suspicion that a growth may be present. The positive van den Bergh reaction will proclaim its obstructive nature and call for immediate action, while the palpation of a firm metallic tumour in the gall-bladder region will at once suggest the

true cause of the symptoms. When there is widespread involvement of the liver, incessant retching and vomiting are most distressing.

In the second group—the so-called *hepatic* type—the onset is insidious, the patient slowly weakens and complains of vague abdominal pains and diarrhoea or constipation. After a short period the liver gradually enlarges and with the advent of a mild jaundice toxæmic symptoms are ushered in. On examination a tense gall-bladder may or may not be felt. There may, in fact, be no physical signs of importance until ascites develops.

In a few atypical cases the first symptoms are mainly due to obstruction of the common bile duct by malignant glands. The growth itself may be symptomless. Jaundice, therefore, painless, progressive and intense, may be the earliest feature. In other cases the initial symptoms are caused by blockage of the cystic duct—mucocoele or empyema of the gall-bladder, while in others the first symptoms are mainly due to widespread secondary growths.

Treatment. The first principle in treatment is prophylaxis. As a correct diagnosis is always difficult and the disease is by no means frequent, cholecystectomy should in the absence of obvious contraindications always be advised for patients suffering from gall-stones or chronic cholecystitis. The early removal of the gall-bladder in such cases is the only sure method of preventing the onset of malignant degeneration. Three varieties of malignant gall-bladder may be found at operation:

1. The gall-bladder is chronically inflamed and may or may not contain gall-stones, or again the organ may be distended with mucus or pus. Cholecystectomy is performed, and on opening the gall-bladder a growth is detected. As might be expected, the results in such cases are excellent.

2. *The gall-bladder is the seat of cancer which has spread and visibly involved an adjacent portion of the liver.* Here, cholecystectomy combined with a wide wedge-excision of the adjacent portion of the liver is indicated, but the results of this operation are most discouraging. In Smithies's series (*Am. J. M. Sc.*, 67:157, 1919) of 23 cases, for instance, although 2 patients were alive at the end of four years, the remaining 21 died immediately after or within eight months of operation. Cooper (*Arch. Surg.*, 35:431, 1937) in a series of 48 cases reported an immediate mortality of 38 per cent, with the aver-



FIG. 154.—PAPILLARY CARCINOMA OF THE GALL-BLADDER.

The tumour was cut across when the gall-bladder was opened, and its two halves are depicted. The tumour is pedunculated and nodular, and to the naked eye it appears to be benign; but its malignant character is evident on microscopical examination. (By courtesy of Mr. G. F. W. Illingworth and the *British Journal of Surgery*.)

age duration of life in 13 survivors as thirteen and a half months and a possible cure in 1 case. In a series of 84 cases reported by Magoun and Renshaw (*Ann. Surg.*, 74:700, 1921) the immediate operative mortality was 10 per cent. Among the 29 patients upon whom only explorations were done, the greatest length of life was three years; of the 26 patients upon whom cholecystectomy was done 6 were alive three and two years, one at eight years, one at nine years and one at eleven years. Twelve did not live longer than one year.

3. The gall-bladder is involved in growth which has already spread extensively into the liver and neighbouring structures, and the common bile duct is blocked by enlarged malignant lymph glands. In such cases nothing surgical should be attempted although external biliary drainage is frequently recommended.

CARCINOMA OF THE BILE DUCTS

Benign tumours of the extra-hepatic ducts are exceedingly rare. Rolleston and McNee (*Diseases of the Liver, Gall-bladder and Bile Duct*, 1929) reported only 10 cases of benign tumour. Marshall (1930) stated that only 4 cases of benign tumour had been seen at the Mayo Clinic in the last 20 years. Comfort and Waltman Walters (*Ann. Surg.*, 93:1142, 1931; and *Proc. Staff Meet. Mayo Clinic*, 10:733, 1935) reported a case of neuroma of the cystic and common bile ducts in which excision of the growth was followed by end-to-end anastomosis of the common hepatic and common bile ducts. This case is quite unique. The patient made an excellent recovery and was in good health eight years after the operation.

The commonest site for innocent new growths is the ampulla of Vater. Christopher (*Surg., Gynec. & Obst.*, 56:202, 1933) reviewed 42 cases of benign tumour of the ampulla, 11 of which were papillomata. Benign tumours of the ducts may be papillomata, fibromata, myomata, lipomata, fibro-adenomata, or adeno-fibromyomata. They are one of the rarest causes of biliary obstruction.

In most of the reported statistics cancer of the gall-bladder occurs about twice as frequently as cancer of the bile passages. As with cancer of the gall-bladder, gall-stones may be found in association with a lesion of the duct, but they are as a rule less common. In Walton's series (*Brit. M. J.*, 1:979, 1936) stones were present in 11

of 31 gall-bladder carcinomata and in 8 of the 33 duct lesions. Outerbridge (*Ann. Surg.*, 57:402, 1931) in a review of 110 cases of carcinoma of the peri-ampullary region found gall-stones associated in only 20 per cent of the cases. While malignant growths may and do arise in any portion of the ducts from the hilum of the liver to the papilla, Marshall (*Surg., Gynec. & Obst.*, 54:6, 1932) has shown that nearly one-third of these lesions occur in the terminal portion of the duct—the ampulla of Vater.

Although the clinical manifestations and the surgical treatment will vary with the position of the growth, the four following varieties have to be considered (fig. 155).

1. Carcinoma of the ampulla of Vater.
2. Carcinoma of the common bile duct between the ampulla and the cystic duct.
3. Carcinoma at the junction of the three ducts.
4. Carcinoma of the common hepatic duct.

Carcinoma of the Ampulla of Vater. This disease is three times commoner in women than in men, and occurs most frequently after the age of 55, although it is of interest that the youngest patient on whom a radical operation was performed was 30 years of age and that some 10 per cent of the patients are in the fourth decade of life.

The clinical features of carcinoma of the ampulla are those resulting from blockage of the common bile duct and the duct of Wirsung and from ulceration of the growth with intestinal bleeding and marked secondary anæmia. Jaundice is the predominant feature and may be intermittent or progressive. In a few cases it is absent, and it tends to become less severe when white bile appears in the ducts. Pain is constant, but when stones occur in the ducts there may be attacks of true biliary colic. The growth in the ampulla is very likely to ulcerate and bleed, with the result that the stools may become tarry and severe anæmia may develop. The continuation of the obstructive jaundice, intestinal bleeding and intractable diarrhœa may give a good clue as to the diagnosis of ampullary carcinoma. The back-pressure upon the pancreas may interfere with its internal secretions, and the absence of the external secretions may lead to recognisable changes in the fæces so that the diagnosis of the site of the obstruction may at times be possible.

Abell (*South. M. J.*, 17:24, 1924) has stressed that pancreatic in-

sufficiency and cholemia rapidly produce loss of weight, asthenia and eventually death. Hunt and Budd (*Surg., Gynec. & Obst.*, 61:651, 1935) in a masterly review express the opinion that the clinical diag-

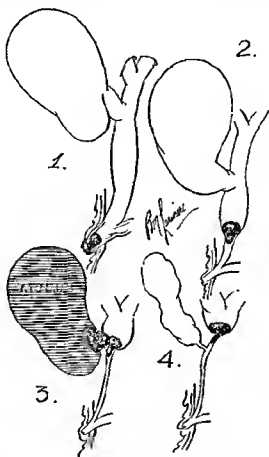


FIG. 155.—CARCINOMA OF THE BILE PASSAGES.

- (1) Carcinoma of the ampulla of Vater.
- (2) Carcinoma of the common bile duct involving the supra-duodenal portion.
- (3) Carcinoma situated at the junction of the three ducts.
- (4) Carcinoma of the common hepatic duct (after Walton).

nosis of ampullary carcinoma is seldom made and that on nearly every occasion the diagnosis has been established either at the time of the surgical exploration or at post-mortem examination.

The diagnostic difficulties of determining the cause of obstructive jaundice are well known and have already been stressed.

Judd has stated that painless jaundice is commonly present in cases of obstruction from stone in the common bile duct and that jaundice associated with colic and pain is more common in cases of carcinoma of the pancreas and ducts than was formerly believed. The frequency with which a cancer of the ampulla of Vater producing obstructive jaundice has been found at autopsy as a small, circumscribed, purely local, movable and operable lesion without any extension at all to surrounding structures and without metastasis urges the adoption of the broad policy of exploratory operation in all cases of obstructive jaundice at a very early stage in the absence of obvious contra-indications.

All surgeons interested in this subject have directed attention to the speedy decline of a patient with an obstructive ampullary lesion. Outerbridge found that the average time elapsing between the onset of the symptoms and death in 47 cases was about seven months. In approximately half of the cases studied by him the duration was less than three months.

Operative Procedures. W. J. Mayo (*St. Paul M. J.*, 3:374, 1901) was the first to operate successfully in a case of cancer of the ampulla of Vater. He performed the operation in two stages. At the first, external biliary drainage was established, and some days later he was able to resect the ampulla of Vater and implant the divided ducts into the posterior wall of the duodenum. Since then nearly 100 cases of transduodenal resection of the ampulla of Vater for growth have been accomplished, and Hunt and Budd have given an excellent summary of the cases which were operated upon between the years 1922 and 1934. It is surprising to see in the literature the number of cases which have been reported as inoperable and in which only a palliative internal drainage operation has been feasible, as there is little doubt that in some two-thirds of the cases the growth is small, mobile and limited to the ampulla and immediate surroundings. Metastases are rare and occur late in the disease, but the patients rapidly decline as soon as the obstruction is complete and in many cases they die from cholæmia before metastases can occur.

At exploration or at post-mortem examination the findings are very similar. The gall-bladder is enormously enlarged, the common bile duct is distended to fullest capacity, and may be the size of a finger or a portion of small intestine, while when the duct is incised more



FIG. 156a.—TUMOUR OF AMPULLA OF VATER VISUALISED UPON OPENING DUODENUM.

From Hunt and Budd, "Transduodenal Resection of the Ampulla of Vater for Carcinoma of the Distal End of the Common Duct," *Surg., Gynec. & Obst.*, Nov., 1935, 61:651-661. By courtesy of *Surgery, Gynecology and Obstetrics*.

often than not white bile will be seen to pour forth under great pressure. When the second portion of the duodenum is incised and the margins of the incision are retracted to display the posterior wall, the button-like ulcerated growth of the ampulla is at once visible.

Treatment. If the condition is regarded as *inoperable* owing to extensive local spread, or if owing to the age and condition of the

patient radical operation is out of the question, it is better to perform cholecysto-jejunostomy than to anastomose the gall-bladder to the stomach or duodenum, as by the latter procedure the stoma would be placed in close proximity to the ulcerated cancer. I prefer cholecysto-jejunostomy by the Roux-in-Y method, *i.e.*, after the proximal jejunum has been divided, an anastomosis is made between the gall-bladder and the distal end of the jejunum and the proximal end of the jejunum is then implanted into the side of the distal jejunum.

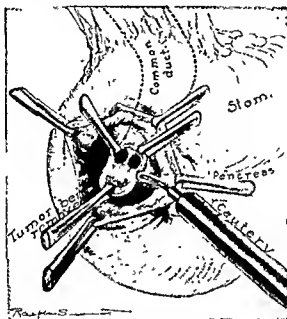


FIG. 156B—METHOD EMPLOYED IN EXCISION OF TUMOUR.

From Hunt and Budd, "Transduodenal Resection of the Ampulla of Vater for Carcinoma of the Distal End of the Common Duct," *Surg., Gynec. & Obst.*, Nov., 1935, 61 651-661. By courtesy of *Surgery, Gynecology and Obstetrics*.

The distal jejunal loop should be brought over the transverse colon rather than through the mesocolon and gastrohepatic ligament, as if the latter route is chosen the long loop of gut may become obstructed either where it is drawn through the mesocolon or by the further spread of the growth.

If the condition is deemed *operable*, numerous methods are available, but perhaps the best is transduodenal excision of the ampullary carcinoma followed by implantation of the cut end of the common

bile duct and pancreatic duct into the posterior wall of the duodenum. The growth is widely excised together with a generous margin of the posterior wall of the duodenum and the terminal portions of the two ducts. The margins of the ducts are then carefully sutured to the cut margin of the posterior wall of the gut with interrupted silk sutures.

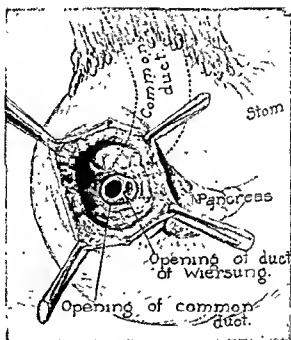


FIG. 156C.—DILATED COMMON AND PANCREATIC DUCTS VISUALISED AFTER EXCISION OF TUMOUR.

From Hunt and Budd, "Transduodenal Resection of the Ampulla of Vater for Carcinoma of the Distal End of the Common Duct," *Surg., Gynec. & Obst.*, Nov., 1935, 61:661-661. By courtesy of *Surgery, Gynecology and Obstetrics*.

Some surgeons at the completion of this operation perform choledochostomy to aid in the process of drainage, but in my opinion this is unnecessary.

By the second method, either internal or external biliary drainage is established, and at a second operation the tumour is widely excised by the transduodenal route.

The third method is that of Whipple, which is described elsewhere in this book.

The operative mortality of palliative external or internal biliary drainage is about 40 per cent, while the death-rate following primary transduodenal resection of the ampullary growth is from 30 to 40 per cent. The performance of the radical operation in two stages for this disease does not in my opinion reduce post-operative fatalities.

Recurrence following transduodenal excision of an ampullary carcinoma has unfortunately been quite frequent, but there have, never-

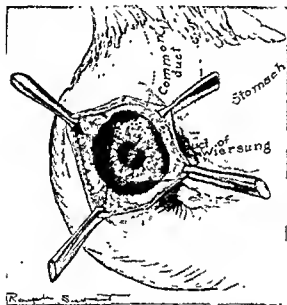


FIG. 156D.—COMMON AND PANCREATIC DUCTS REIMPLANTED INTO POSTERIOR WALL OF THE DUODENUM.

From Hunt and Budd, "Transduodenal Resection of the Ampulla of Vater for Carcinoma of the Distal End of the Common Duct," *Surg., Gynec. & Obst.*, Nov., 1935, 61.651-661. By courtesy of Surgery, Gynecology and Obstetrics.

theless, been some outstanding successes. Korte's patient, for instance, was living and well twenty-two years after operation, and among patients living two years or more are those of Clar, Lewis, Oehler, Fulde, Pemberton, Cabot, Lauwers, Oliani, Tinani, Morin and Novarro.

Carcinoma of the Common Bile Duct between the Ampulla and the Cystic Duct. Growths in this region simulate clinically carcinomata of the head of the pancreas, but the duct of Wirsung escapes

and so the pancreas is free to carry on its usual functions both with regard to its external and internal secretions.

The gall-bladder and upper portion of the main bile duct become enormously distended with thick tarry bile. If the gall-bladder has been the seat of calculous cholecystitis, it will of course be incapable of distension, but it is nevertheless tense and firm from pent-up secretions.

In some cases the bile may be so concentrated that it gives a shadow in the X-rays similar to that seen after the administration of Graham's dye. Advanced cases, again, may show a diminution of the jaundice in which case the distended ducts and gall-bladder may be filled with white bile.

Operation. If the growth proves impossible to resect, biliary intestinal continuity should be established by anastomosing the gall-bladder to a loop of proximal jejunum. If, on the other hand, the malignant lesion is localised and confined to a small segment of the common bile duct it may be possible to perform an economical resection and join the two cut ends of the duct together over a T-tube—choleodocho-choledochostomy. But in most instances a wide resection of the common duct is indicated and an anastomosis between the upper cut end of the duct with the duodenum or jejunum is indicated.

Carcinoma at the Junction of the Three Ducts. Here again the clinical picture is similar to that of a tumour of the ampulla of Vater, but bile cannot enter the gall-bladder which becomes distended with its own mucoid secretions. We have therefore a mucocele of the gall-bladder with marked distension of the upper reaches of the common hepatic duct which may be filled with dark or white bile.

If on exploratory operation the growth cannot be excised, some relief may be afforded by anastomosing the common hepatic duct with the duodenum or jejunum, or if the patient's condition is so poor as not to permit of this the common hepatic duct should be drained on to the surface by means of a T-tube. Where, however, resection is possible, a generous margin of the common hepatic duct and common bile duct should be removed in one block together with the gall-bladder.

The operation is completed by implanting the cut end of the common hepatic duct into the duodenum or jejunum.

Carcinoma of the Common Hepatic Duct. In these cases jaundice is very marked and the gall-bladder collapsed. A correct pre-operative diagnosis is, of course, rarely made, and at operation it is most unusual for any portion of the dilated duct to be seen above the growth and then it is not possible to overcome the obstruction. If, however, a portion of the duct is accessible the only procedure that remains is to perform external biliary drainage by means of a rubber catheter.

CHAPTER 3

GALL-STONES AND CHOLECYSTITIS

The subjects of gall-stones and inflammatory conditions of the gall-bladder are so intimately associated both clinically and from a pathological standpoint that they will here be discussed together for the sake of convenience.

Cholecystitis may originate independently of gall-stones. Chronic gall-bladder disease is the commonest organic cause of digestive disturbances, and is responsible for a considerable amount of ill-health and invalidism.

The frequency of calculus formation within the gall-bladder has been variously estimated as from 5 to 25 per cent of all subjects. Piersol (1936) published an analysis of the admissions to the Gastro-Intestinal Clinic of the University of Pennsylvania Hospital and showed that 16.3 per cent of the patients were diagnosed as suffering from gall-bladder disease. Gall-stones have been demonstrated in 10 per cent of all autopsies in individuals of all ages (Crump). The incidence is, of course, higher if adults only are considered. Thus Hansen (*Acta chir. Scandn.*, 62:483, 1927) found the frequency to be 24.7 per cent in patients over the age of 40, while Menzler (*Arch. Surg.*, 14:14, 1927) computed it at 21.6 per cent. The generally accepted estimate—that given by Wilkie and Illingworth—of the frequency of calculous cholecystitis is 10 per cent for adult subjects.

Fully 80 per cent of all operations performed upon the gall-bladder and bile passages are for gall-stones or the complications produced by gall-stones. This is well seen in Wilkie's record of 1,000 gall-bladder operations in which he found that over 800 were undertaken for cholelithiasis.

Gall-stones are commoner in females than in males, the ratio being five females to one male, and especially in stout multiparæ. The characteristic type of patient—the "fair, fat and forty," flatulent, fecund female—is emphasised by all writers. Why fat women in middle life are so prone to have gall-stones has baffled the imagination of all

investigators. The increase of cholesterol in the blood—or rather in the bile—during pregnancy has been offered as a determinative factor, but, as Hertzler remarks, “one may have gall-stones without getting either fat or pregnant.”

Gall-bladder troubles are, however, quite common in men, and it may be emphasised that cholecystitis occurs in young men and young women and even in children. These facts are, I believe, not yet sufficiently and universally recognised. I have performed cholecystectomy for calculous cholecystitis in patients aged 9, 11 and 14 respectively.

Types of Gall-Stones (fig. 157). The modern conception of gall-stone formation is due largely to the work of Aschoff and Bacmeister. In their illuminating monograph *Die Cholelithiasis* (1909) they show that the variations in the naked-eye appearances, the structure and the chemical composition of the different types of stones are all indicative of different modes of origin.

The cholesterol solitaire, pure in colour and chemical composition and almost wholly crystalline in structure, has nothing in common with the small black cinder-like pigment concretions, and these in their turn are entirely different from the common faceted stones of mixed composition.

The modes of origin and causes of gall-stones can only be determined therefore by considering the different types of stones individually.

Five main types of stone are recognised:

1. Single pure cholesterol stone—cholesterol solitaire.
2. Multiple pure cholesterol stones.
3. Pigment stones.
4. Stones of mixed composition.
5. Pure calcium carbonate stones.

The Single Pure Cholesterol Stone (fig. 157). This stone is of moderately common occurrence, being found in some 25 per cent of cases of gall-stones. The solitaire is rounded or ovoid, smooth or slightly nodular on its surface, very light in weight, of waxy consistency, semi-transparent, and of a pale yellow amber colour. It varies considerably in size. It may be as small as a pea, elongated as a date stone, or as large as a damson. On section it has a peculiar radiating crystalline structure—numerous coarse, tightly packed, yellowish or scintillating diamond-like cholesterol crystals which extend from the core of the



FIG. 157.—GALL-STONES.

Top row from left to right: large ovoid stone which completely filled the gall-bladder; stones of mixed composition; large solitary gall-stone of mixed composition.

Second row: two pure cholesterol stones; stones of mixed composition; pigment stone.

Below this: cholesterol solitaire.

Bottom row: large barrel-shaped faceted stones, stones of mixed composition; cholesterol solitaire.

stone, fanwise to the amorphous periplieral layer. In some cases it will be seen that the stone is composed almost wholly of cholesterol, in others there is a minute amount of bilirubin in the center, while in others again, as the result of long-standing secondary infective changes, the outer shell consists of deposits of calcium salts and compressed bile pigments—cholesterol combination stone. It may be taken as a fact that this combination stone is always associated with inflammatory changes in the gall-bladder and is almost invariably accompanied by multiple faceted stones formed at the same time as the outer coating of the solitaire.

I am in agreement with those who hold that the pure single cholesterol is of metabolic origin, that it is of aseptic formation, that it is formed by precipitation of cholesterol derived from the bile. Illingworth who has made a special and careful study of this subject writes:

It is true that many pure cholesterol stones are associated with cholecystitis, especially in operation cases, but this may well be due to the fact that these stones give rise to few symptoms when aseptic and demand surgical treatment only when secondary infection has occurred. A more accurate guide may be obtained from autopsy observations, and here the evidence is overwhelmingly in favour of an aseptic origin. This may be seen, for example, from the observations of Gross (*J. Pathol. and Bacteriol.*, 32:503, 1929) who, in a statistical summary of autopsy cases from the Leeds General Infirmary, found that only 3.2 per cent of solitary cholesterol stones were accompanied by cholecystitis. In an uncomplicated case of pure cholesterol stone, the gall-bladder is thin walled, free from adhesions, and of normal blue green colour. Histological evidence provides no evidence of inflammatory change, and bacteriological investigation fails to demonstrate the presence of organisms.¹

Multiple Pure Cholesterol Stones (fig. 157). These stones again appear to be aseptic in origin, although cholecystitis may supervene before operative treatment proves necessary. They are frequently associated with a strawberry gall-bladder (fig. 158). The stones vary considerably in appearance and structure, but the common variety is slightly larger than a pea, pale yellow in colour, and nodular on the surface—like an unripe mulberry. On section they have a radiating crystalline structure in every way comparable to that of the solitaire. In nearly all the specimens the core is stained brown or even green with bile pigments. It is thought that these calculi, like

¹ Illingworth, *Edinb. M. J.*, 43:481, 1936.

the solitary pure cholesterol stone, develop under aseptic conditions by a process of slow crystallisation of cholesterol from the bile. They probably owe their multiplicity to the presence in the bile of multiple pigment granules at the time when crystallisation was taking place.

Pure Pigment Stones. These are comparatively rare and account for only 5.6 per cent of the 300 cases examined by Illingworth. According to Miyake (*Arch. f. klin. Chir.*, 101:54, 1913) they are the commonest type of biliary stone in Japan. They vary considerably in size, shape and colour. The common variety are multiple, small, rounded, hard, cinder-like structures with nodular surfaces, being dark grey, pea green or black in colour. In another type the stone may be moderately large and markedly spiculated. They are composed of bilirubin (commonly) and biliverdin (rarely) in combination with calcium salts. They do not usually contain any cholesterol. Pigment stones are essentially aseptic formations, the result of precipitations of either bilirubin or biliverdin and calcium from the bile. The stones may form in the healthy gall-bladder or in the bile passages. The biliary mud and putty-like masses which are sometimes encountered in the biliary passages are composed of similar material. The presence of an excess of pigments in the bile appears to be one of the essential causative factors, and pigment stones are common as a complication of such diseases as acholuric jaundice in which there is an excessive destruction of red blood pigments excreted by the liver. Pigment stones may follow partial or complete obstruction of the common bile duct.

Stones of Mixed Composition (fig. 157). Stones of mixed composition—or, as they are sometimes called, post-infection gall-stones—are

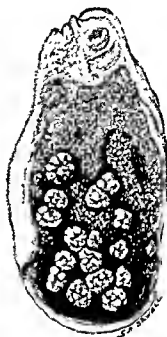


FIG. 158.—STRAWBERRY GALL-BLADDER.

Multiple pure cholesterol stones situated in a gall-bladder which is the seat of cholesterosis. (Hunterian Museum, Royal College of Surgeons.)

the commonest variety encountered (65 per cent). They consist principally of cholesterol, bile pigments, calcium salts and albuminous matter. They form in a gall-bladder which is already the seat of chronic inflammatory change and are usually many in number, faceted by mutual pressure, mixed in structure, and green or yellow depending upon the amount of pigment that is present (fig. 159).

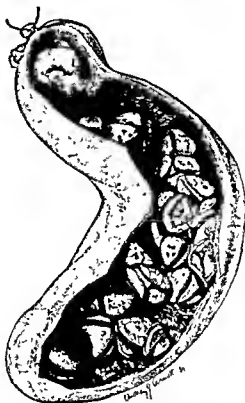


FIG 159.—SPECIMEN OF A VERY MUCH ENLARGED GALL-BLADDER CONTAINING MULTIPLE FACETED STONES WITH ONE STONE IMPACTED IN THE NECK OF THE GALL-BLADDER. (MUSEUM, LONDON HOSPITAL)

On section they are nearly always laminated, the layers being alternately formed of cholesterol and pigment calcium. Each stone has a nucleus of organic material consisting of bacteria or desquamated epithelium and a mixture of cholesterol and calcium bilirubin.

Less often there is a single large ovoid stone occupying a contracted gall-bladder (fig. 160). The stone forms a complete cast of the interior of the gall-bladder (fig. 157) Stones of such a character are

roughly nodular on the surface, the surface nodules fitting closely into the irregularities of the gall-bladder mucosa. They are usually of a pale yellow, olive or jade green colour. When there are two or three large stones they may be barrel-shaped with facets at either end (fig. 157). If faceted gall-stones are found together with an oval cholesterol stone it may rightly be concluded that infection of the gall-bladder followed the formation of the single stone.

Calcium Carbonate Stones. The majority of gall-stones contain a trace of calcium carbonate, but on rare occasions specimens may be seen which are formed of *pure* calcium carbonate. These stones are often about $\frac{1}{4}$ to $\frac{1}{3}$ inch in diameter, white in colour, roughly nodular on the surface, and stony hard. In exceptional cases the gall-bladder may be filled with white calcium carbonate cement (Schubb and Goodstone). The factors which lead to the formation of this deposit are at present unknown.

Cholesterosis of the Gall-Bladder. This condition, sometimes known as the strawberry gall-bladder, in which the epithelial lining and stroma of the mucous membrane of the gall-bladder is infiltrated with lipoids and especially with cholesterol, is of comparatively frequent occurrence. It affects middle-aged patients, and the incidence bears no relation to sex or social status. There are two types: In the first there is a diffuse infiltration of the entire mucous membrane of the gall-bladder, while in the second a few small lipid-laden papillomata are seen. The detachment of these may furnish the nuclei for mulberry-like cholesterol stones. Moynihan (*Ann. Surg.*, 50:1265, 1909) gave the first description of the macro-



FIG. 160.—A GALL-BLADDER SHOWING MARKED CHRONIC CHOLECYSTITIS.

The gall-bladder has contracted down on the single stone within its lumen. (Museum, London Hospital.)

scopic appearance of the disease, while Mentzer (*Am. J. Path.*, 1:383, 1925) was the first to make use of the term cholesterosis.

Much of our present knowledge of the strawberry gall-bladder we owe to Boyd (*Brit. J. Surg.*, 10:337, 1927) who accurately described the nature of the lipid involved in the infiltration. The ætiology of the condition is as yet obscure.



FIG. 161.—CHOLESTEROSIS OF THE GALL-BLADDER.

(Museum, London Hospital)

Cholesterosis usually occurs in association with a mild catarrhal cholecystitis, and cholesterol stones are found in the gall-bladder in nearly half of the cases. To the naked eye, the exterior of the gall-bladder may appear healthy or slightly thickened, and when the organ is slit open the characteristic brick-red congested mucous membrane will be seen to be speckled with bright yellow nodules (fig. 161). In some specimens the villi are markedly rugose and appear to be over-burdened with lipid, while in others only a few scattered tiny white "warts" can be discerned.

The condition is of clinical importance because it is sometimes the forerunner of cholesterol stones, and even when stones are absent severe abdominal pain, biliary colic and transient attacks of jaundice may occur. It is impossible to make a correct pre-operative diagnosis,

as cholecystograms show normal gall-bladder shadows and chemical tests are unreliable.

Some patients, and especially those suffering from recurrent attacks of biliary colic, are operated upon as cases of gall-stones. At operation the gall-bladder may appear healthy, it may show evidence of a mild degree of chronic inflammatory change, it may contain a few rounded bead-like gall-stones, or small yellow spots may be seen through the semi-diaphanous gall-bladder wall.

The correct treatment is cholecystectomy, and the immediate and late results appear to be quite satisfactory.

Mucocele of the Gall-Bladder. A solitary cholesterol stone may form and lie in the gall-bladder for many months or years without giving rise to any symptoms at all. The stone may, however, perchance become impacted in the neck of the gall-bladder or in the cystic duct and when it does so a sharp attack of biliary colic results. The colic is severe but usually afebrile, and after a few hours the pain disappears and the patient is left with a sore aching area below the right costal margin. A few days after such an attack the patient feels well again and does not suffer any dyspeptic symptoms, but sooner or later it is common for these attacks of colic to recur and become more frequent, until eventually the stone becomes entrapped in the cystic duct and is incapable of escape. A mucocele of the gall-bladder then develops. With this is associated a chronic dull pain in the right upper quadrant of the abdomen, and flatulence and epigastric distress, especially after fatty meals.

On examination the painless, tense, distended gall-bladder can be felt as a pyriform tumour beneath the right costal margin. An X-ray examination of the gall-bladder following the administration of iodophthalein will show that the organ has failed to fill with bile-laden dye. At operation the pale, distended, freely mobile sausage-shaped gall-bladder should be emptied of its mucoid contents to facilitate the performance of cholecystectomy. In cases such as these there is no obligation to explore the common bile duct.

Acute Obstructive Cholecystitis. By far the commonest single cause of acute cholecystitis is obstruction of the neck of the gall-bladder or of the cystic duct by a stone (fig. 162). This is confirmed by post-mortem examinations and by operative findings.

Acute non-calculous cholecystitis is on rare occasions encountered



FIG. 162.—ACUTE OBSTRUCTIVE CHOLECYSTITIS.

(Hunterian Museum; Royal College of Surgeons.)

in the course of acute infective diseases such as typhoid, in pneumonia, in streptococcal and *B. coli septicæmia*, or even in the more virulent forms of influenza. The infection in such cases is blood borne (commonly) or bile borne (rarely).

It is usual to find the following forms of acute cholecystitis described in text-books:

(1) catarrhal; (2) hæmorrhagic; (3) suppurative; (4) ulcerative; (5) phlegmonous; (6) gangrenous.

These, however, represent degrees or stages in the inflammatory process rather than distinct types. It is true that gall-stones may lie dormant in a chronically inflamed gall-bladder for an indefinite period and give rise to little more than occasional bouts of flatulence, epigastric uneasiness, or a feeling of localised discomfort. When impaction occurs, and this is by no means an infrequent event, acute obstructive cholecystitis results.

Clinical Picture. The onset may be gradual, but more often it is sudden and fulminating. In the former case a persistent dull ache under the right costal margin is by degrees replaced by a sharp pain which increases in intensity and reaches a maximum in about forty-eight hours, while in the latter an unusually severe attack of biliary colic denotes that impaction has occurred. The patient is doubled up at the height of each seizure and writhes in agony as each gripping pain attains a crescendo-like ferocity. A measure of relief is afforded when the stone loosens and allows the purrid bile to drain into the common duct, or when liberal doses of morphia are given. The pain of biliary colic is chiefly localised to the right upper quadrant of the abdomen, but at times it may be diffused over the entire epigastrium or be referred mainly to the right flank or back. After a variable period, usually some hours, the pain changes in character. Its colicky nature is replaced by a dull throbbing which is felt most acutely near the tip of the ninth costal cartilage or lower down on a level with the umbilicus. Nausea, retching, vomiting and the belching up of large quantities of gas, mild rigors, a rise in temperature and pulse-rate, a sensation of tightness in the right hypochondrium and a catch in the breathing are all characteristic features of the early stages of acute obstructive cholecystitis.

At the end of forty-eight hours after the onset of the acute attack—and this is the critical period—either resolution will follow with

disimpaction of the stone, or complications—empyema, gangrene, perforation or peritonitis—will ensue. The clinical manifestations *after* the first forty-eight hours are most variable and at times even misleading. It is not uncommon to find that serious complications are present in the absence of significant signs or symptoms which would point to a grave pathological condition of the gall-bladder.

When the patient is examined during the acute phase he will be found to be apprehensive and distressed, his face flushed, his tongue coated white or yellow, and the upper half of the right rectus muscle on guard, fixed and tender, and the cæcum and ascending colon distended and tympanitic. Jaundice may be in evidence and there may be traces of bile in the urine which is often scanty, highly coloured and concentrated.

In some cases the tensely swollen gall-bladder may be felt through the board-like abdominal muscles, or an indefinite tender mass may be made out below the inflamed liver margin, while in others the ballooned cæcum may suggest a diagnosis of acute retrocæcal appendicitis or obstruction of the large intestine.

An examination of the chest will commonly show a slight degree of congestion of the lower lobe of the right lung, this being due to fixation of the inflamed right cupola of the diaphragm.

Acute obstructive cholecystitis may be confused with acute perforated peptic ulcer, acute hæmorrhagic pancreatitis, acute appendicitis, acute pyelonephritis, intestinal obstruction, or pneumonia. In the average case, however, the physical signs leave little room for doubt.

Pathology. In the early stages the gall-bladder will be seen to be distended, congested and "angry" with inflammation. Its walls are thickened, œdematous and fleshy, and the mucous membrane is swollen, hæmorrhagic or ulcerated. The mucous surface is red or maroon in colour and may show areas of necrosis. The contents consist of thin white bile, yellowish mucopus or dark brown decomposing blood laden with bacteria and leucocytes. The commonest organisms cultivated from the contents of the gall-bladder are *B. coli* and streptococci. In some of the fulminating cases *B. welchii* will be discovered. The liver is often enlarged, pale yellow-brown in colour, has rounded edges and is friable to a marked degree. The omentum and the adjacent portions of stomach and duodenum may be attached by fibrinous adhesions to the inflamed surface of the

tense gall-bladder. When disimpaction occurs the bile is free to be discharged through the cystic duct into the common duct. The gall-bladder then shrinks, and the œdema slowly disappears. The gall-bladder is now a chronically inflamed organ, crippled in the extreme, surrounded by fibrous adhesions and prone to attacks of acute or sub-acute inflammation.

In those cases in which the acute inflammatory process continues unabated, serious complications such as gangrene, perforation or suppurative pylephlebitis may arise.

Gangrene may lead to perforation of the gall-bladder with a localised abscess or general peritonitis. A localised abscess, however, is a more common occurrence. The gangrene is more prone to occur in elderly patients owing to vascular rigidity. It is difficult to determine the incidence of gangrenous cholecystitis, as reports from different sources show wide variations. Taylor (*Surg., Gynec. & Obst.*, 63:296, 1936) states that 2.07 per cent of 1,400 cases with gall-bladder troubles were found to be gangrenous, and 22.5 per cent of all acute gall-bladder lesions. In Heuer's 74 cases of acute cholecystitis (*Ann. Surg.*, 105:758, 1937) 25 per cent were gangrenous, and in Judd and Phillip's series (*Ann. Surg.*, 98:771, 1933) gangrene was present in 12 per cent of acute gall-bladder lesions. Zinninger (*Ann. Surg.*, 96:406, 1932) reported 15 instances of gangrene or empyema (17 per cent) in 89 cases of acute cholecystitis, while Mentzer (*Surg., Gynec. & Obst.*, 55:709, 1932) recorded 43 cases of perforation, gangrene or empyema (32 per cent) in 134 acute gall-bladder lesions. Estes (*Am. J. Surg.*, 40:197, 1938) in 78 consecutive acute cholecystitis cases found 34 (43.4 per cent) instances of gangrene.

At operation one of two courses may be adopted: Either the gangrenous gall-bladder may be resected, as would be the case with a gangrenous appendix, or partial cholecystectomy—either by the method of Thorek or Estes—may be performed. Wilkie was in the habit of trimming away the necrotic portion of the gall-bladder and inserting a tube into the lumen of the remaining viable portion. Estes, on the other hand, recommended that after the gall-bladder had been emptied of its contents by aspiration the organ should be slit down from the fundus to within 1 cm. of the cystic duct, and after removing stones and swabbing the gall-bladder mucosa thoroughly with iodine, the free flaps on either side of the portion of

the gall-bladder which is adherent to the liver are cut away with scissors, and after oversewing the cut margins, cigarette drains are placed down to the cystic duct, and omentum is drawn over and attached to each margin of the cut gall-bladder wall to prevent adhesions to the nearby viscera.

Thorek's technique of cholecysto-electro-coagulectomy (*Am. J. Surg.*, 32:417, 1936) is described on page 762.

What is the total incidence of perforation of the gall-bladder? Here again figures show very wide variations. Gordon Heyd (*Surg., Gynec. & Obst.*, 65:550, 1937) states on good authority that perforation occurs in 10 per cent of patients subjected to early operation for acute cholecystitis, while Glenn (*Surg., Gynec. & Obst.*, 69:431, 1939) found the incidence to be 7.7 per cent in 219 cases of acute cholecystitis which were operated upon at the New York Hospital.

Perforation may occur in gall-bladders which do not show gangrene. In Estes' series (1938) there were 9 cases of perforation (11.5 per cent), 7 with localised peri-cholecystic abscesses and 2 with acute general peritonitis. Estes rightly states that the statistical incidence of gangrenous cholecystitis in acute cholecystitis varies according to whether clinical or operative criteria are used, and whether mild pathological changes are included as evidence of acute disease. He holds the view that acute gangrenous cholecystitis cannot be considered as uncommon since it will be found in approximately one-fifth to two-fifths of all frankly acute cholecystitis cases.

Three types of perforation are commonly recognised:

1. Acute perforation in which rupture has occurred with leakage into the general peritoneal cavity. The peritonitis which has resulted is due to a lack of protective adhesions. The prognosis in such cases is always grave, as the mortality is about 30 per cent.

2. Sub-acute perforation. Here the perforated gall-bladder is surrounded by an abscess—sub-hepatic or sub-phrenic—which is sealed off by adhesions from the general peritoneal cavity. The treatment is drainage both of the abscess and of the gall-bladder.

3. Chronic perforation in which there is fistulous communication between the gall-bladder and some other viscus, generally the duodenum and hepatic flexure of the colon. It is in such cases as these that gall-stone ileus may occur.

The subject of *gall-stone ileus* has received special consideration

from Barnard (*Contrib. Abdominal Surg.*, 1908) and by Wakeley and Willway (*Brit. J. Surg.*, 23:377, 1935). Gall-stone ileus is the cause of acute intestinal obstruction in 1 to 2 per cent of all such cases. Courvoisier (1900) estimated that the commonest sites of impaction were the duodenum (22.2 per cent), the lower ileum (65.4 per cent), the ileocaecal junction (10 per cent) and the sigmoid loop (2.4 per cent). In Grey Turner's series there were 87.5 per cent of impactions of the small intestine, while in 12.5 per cent of cases the impaction occurred in the pelvic colon.

It is of course more frequent for the fistula to occur between the gall-bladder and the duodenum than between the gall-bladder and the colon. Impaction takes place more often in the last 20 inches of the ileum, due to the fact that the gut narrows here. The majority of patients are elderly females, the average age incidence being 60-70.

The signs and symptoms are those of acute intestinal obstruction, and the condition is associated with a mortality of about 50 per cent.

The impacted stone is discovered at exploratory laparotomy and should, if possible, be milked into a healthy portion of proximal gut and removed by an incision made into the anti-mesenteric portion of the intestine. The incision in the gut should be closed in a transverse manner to prevent any narrowing of the lumen of the bowel. If the stone is firmly impacted and cannot be dislodged, one of two courses should be adopted: either an incision should be made through the intestine at the site of impaction and the stone thus removed, or if the gut is devitalised resection of the affected portion of the intestine should be carried out and intestinal continuity restored by end-to-end or side-to-side anastomosis.

Treatment. No hard and fast rules can be laid down with regard to the treatment of acute cholecystitis. In some cases an early operation is advisable; in others a policy of delay is clearly indicated. It is generally necessary to consider each case as an individual problem. There are many surgeons who hold that the operative mortality in the early stages of acute cholecystitis is prohibitive and that this death-rate may be diminished by a resting period of watchful waiting.

The advocates of *delayed operation* state that:

1. In some 80 per cent of cases one may confidently expect the acute phase to subside under appropriate medical measures.

2. After a variable period, which may extend from ten to twenty-

eight days, excision of the gall-bladder can be undertaken with greater safety than during the acute attack owing to the subsidence of hepatitis and peri-cholecystitis. It is claimed that the average early operation is technically more difficult owing to the œdema which is present and to the tendency to a free oozing. It is for this reason that the common bile duct is more prone to be injured and that the majority of patients will be subjected to cholecystostomy, whereas after a course of expectant treatment excision of the gall-bladder can in most instances be safely carried out.

3. Gangrene and perforation of the gall-bladder, giving rise to a localised or generalised peritonitis, seldom results from acute cholecystitis and the risks of early operation are greater than the risks of death from peritonitis.

4. A lesion of the common bile duct will be overlooked more frequently in early surgery because jaundice cannot usually be detected when the patient is first examined. If jaundice appears after the operation the surgeon will be in a quandary as to whether stone or injury to the common bile duct is present. Exploration of the common bile duct during the acute phase is beset with many difficulties and dangers on account of the marked œdema.

5. The operative mortality rate and morbidity rate of delayed operations are lower than of immediate operation.

The general policy of those who advocate delayed operation is this: the patient is observed carefully and treated medically—expectant treatment—to see if the acute attack will subside. If complications occur or if there is no evidence of subsidence in the acute phase, operation must be undertaken.

The essential features of *expectant treatment* are:

1. After a brief period of watchful waiting, the diagnosis is still in doubt.

2. The pulse-rate is steadily rising.

3. On repeated physical examinations there is found to be a persistence of abdominal tenderness and localised rigidity.

4. Pain is severe and cannot be controlled easily by morphia or other measures.

5. Toxæmia is increasing. This is evidenced by the unmitigated distress of the patient, repeated vomiting, rigors, quickened pulse-rate and a dry brown tongue.

6. There is a rising leucocyte count. The white blood cells rise to 15,000 per c.cm. or more.

7. The advent of jaundice, particularly when this is associated with pyrexia and rigors.

The proponents of *early operation* believe that:

1. In cases of acute cholecystitis it is extremely difficult to decide whether the condition will subside under conservative treatment or become progressively worse. The exact nature and the extent of the inflammatory lesion are often a question of speculation before the abdomen has been opened, as advanced grades of inflammation of the gall-bladder *may* exist in the complete absence of signs and symptoms, whereas in patients presenting the same condition clinically wide variations in the pathological changes may be observed at operation. For instance, it is not an uncommon experience after a prolonged course of conservative treatment, during which time the patient has been afebrile and symptomless, to find at operation that the gall-bladder is a bag of pus and that a localised abscess or a patch of gangrene is present.

2. Less than half of the cases resolve satisfactorily under palliative treatment. The incidence of perforation and peritonitis is higher than is generally estimated and early operation removes this grave danger.

3. Early operation is technically easier because fibrinous adhesions are encountered without the strong fibrous adhesions which are the rule later.

4. There is a lower mortality or morbidity rate.

5. Contrary to expectations cholecystectomy is often feasible and simple owing to the œdematous peri-cholecystic adhesions which strip away very readily.

It is my practice to advise early operation after a brief course of preparatory treatment for most cases of acute cholecystitis, especially when they are seen within forty-eight hours of the onset of the attack. The exceptions include:

1. Very obese patients who show evidence of hypostatic congestion of the base of the lungs.

2. Feeble and aged patients.

3. Those suffering from associated disorders such as diabetes, phthisis, nephritis and so forth.

4. Those in whom the attack has been very mild and appears to be subsiding as previous attacks have done.

The ideal treatment is *cholecystectomy* (often combined with exploration of the common bile duct and *choledochostomy*) for these reasons:

1. The useless, damaged and infected organ is removed.
2. The operation in experienced hands presents no especial difficulties.
3. An otherwise necessary secondary operation is avoided.
4. Convalescence is shorter, smoother and attended by fewer complications; there is, in addition, less pain and fewer dressings are required.

But the risks in each individual case must be carefully balanced. If at the completion of an obligatory *cholecystectomy* the patient's condition is not satisfactory or if exploration of the common bile duct presents unusual difficulties, it is better to omit exploring the ducts. Again, if the patient's condition makes it imperative that the simplest and quickest surgical procedure should be undertaken, or where removal of the gall-bladder is rendered impossible on account of numerous surrounding vascular adhesions, then *cholecystostomy* is to be preferred. But I perform *cholecystostomy* rarely and regard it as an emergency palliative measure which will probably be followed by trouble later on.

Every surgeon must be impressed by a comparison between the figures given by Graham and Hoefle on the one hand, and Pennoyer on the other. The former (*Ann. Surg.*, 108:874, 1938) reported 167 cases of acute *cholecystitis* in which operation was carried out within forty-eight hours of the onset with a mortality of 3.5 per cent. In this series there were 126 *cholecystectomies*. Pennoyer (*Ann. Surg.*, 107:543, 1938) showed that in a series of 300 cases of acute *cholecystitis* treated by the delayed method there was a mortality of 10 per cent. His figures are in striking contrast to the 3.5 per cent mortality of Graham and Hoefle's cases in which operation was carried out within forty-eight hours of the onset, and is to my mind a strong argument in favour of immediate surgical measures. When the case is seen for the first time after forty-eight hours, early operation may yet be indicated when an unduly large tense gall-bladder can be palpated, suggesting that perforation is imminent, when it is clear from

the physical signs that a localised or generalised peritonitis is present, and when toxæmia shows no evidence of diminishing in spite of adequate measures to combat it. In a general way it may be stated that for the average case seen after forty-eight hours, conservative measures followed by delayed operation offer the best prospect of success and that the risks of surgical intervention during the third, fourth or fifth day after the onset are greater than if more cautious methods are adopted.

Chronic Cholecystitis. Chronic cholecystitis is due to bacterial infection. Stagnation of bile and disturbances of lipoid or cholesterol metabolism are well-known predisposing factors. As previously stated, chronic cholecystitis may precede gall-stones or may follow them as a result of their obstructive effects.

Organisms can be obtained on culture in from 50 to 70 per cent of cases, more frequently from the gall-bladder wall and adjacent lymphatic glands than from the bile itself (A. L. Wilkie, *Brit. J. Surg.*, 15:450, 1928). The predominating infecting organisms are *B. coli* and streptococci. It is generally considered that they are derived principally from the intestinal tract and reach the gall-bladder either by excretion in the bile or by passing through the liver into the systemic circulation and so in time reaching the gall-bladder wall (Patey and Whitby, *Brit. J. Surg.*, 20:580, 1932). Such a bacteriæmia is known to occur frequently in diseases of the gastro-intestinal and genito-urinary tracts or even in cases of constipation. In some cases, as Rosenow has shown, the gall-bladder is infected by blood-borne bacteria from distant sources such as the teeth, tonsils, pharynx, kidney, prostate, etc. These organisms infect the gall-bladder wall only in the presence of some predisposing factor such as a stone, cholesterosis, or biliary stasis.

The normal gall-bladder is sea-green or blue-green in colour. This is due to the fact that the walls of the organ are translucent and transmit the colour of the bile within. When the gall-bladder is gently compressed with the fingers and thoroughly emptied of its contents it will be seen that its walls are thin and flexible and that it takes on a pale salmon pink hue.

It is difficult to detect early chronic inflammatory changes. It will be noted that the following features are outstanding and characteristic of mild cholecystitis:

1. The gall-bladder is slightly opaque and somewhat pale in colour. It loses its typical blue-green translucency.

2. There is an excess of subserous fat. The fat is evenly distributed, coating the entire wall of the gall-bladder and imparting to it a whitish or yellowish opacity.

3. The cystic lymphatic gland is considerably enlarged and elastic.

4. There is a definite degree of subcapsular fibrotic thickening of the liver adjacent to the viscus.

When the disease is well established, the walls of the gall-bladder become thickened and inelastic and present a pearly white appearance (fig. 163). The gall-bladder may be normal in size or it may be enlarged and tense with bile and with contained stones when impaction has occurred, or again it may be small and shrunk, fibrotic and deformed. In an extreme case it may be represented as a thickened fibrous cord containing a few faceted stones. The mucous membrane may show early inflammatory changes—catarrhal cholecystitis, or again it may be markedly congested, ulcerated from the pressure of calculi, pitted or scarred. In a few late cases the walls may become calcified (fig. 164). The bile may be of a healthy green or yellowish hue, it may be odourless and free from organisms, while again it may be pale and opalescent—white bile; turbid or muddy—mucopus; dark brown; or thick and tarry and laden with biliary mud. The gall-bladder may be adherent to the surrounding structures, the pylorus, the first portion of the duodenum, the hepatic flexure of the colon or the great omentum.

Clinical Features. These depend upon dysfunction of the gall-bladder caused by inflammation or the presence of stones, or upon

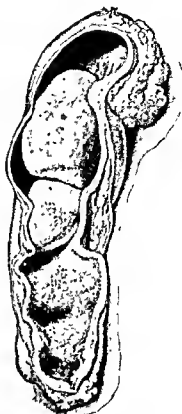


FIG. 163.—CHRONIC CHOLECYSTITIS.

The gall-bladder contains large faceted stones.

reflex pylorospasm. In more advanced cases some of the clinical manifestations are due to toxic absorption from the diseased gall-bladder.



FIG. 164.—STRAIGHT X-RAY SHOWING CALCIFIED GALL-BLADDER (LAURIE).

The outstanding symptom is flatulent dyspepsia. The patient complains of distension after meals, and particularly after fatty food has been taken. A large meal often aggravates the epigastric distress and never brings relief as would be the case in uncomplicated chronic

duodenal ulcer. In some instances the bloating of the epigastrium may be extreme and be associated with a marked degree of belching. Heart-burn is present in half of the cases, although there is often achlorhydria. The patient frequently complains of a pain below the angle of the right scapula, beneath the right costal margin and sometimes in the right flank, particularly on stooping, during exercise, or occasionally after a cold bath, and owing to this pain exercise is avoided and weight is consequently increased. When impaction occurs there may be a dull constant ache in the right upper quadrant of the abdomen, or again there may be intermittent attacks of biliary colic and with this is associated the so-called bilious vomiting and marked nausea. Jaundice occurs in over 25 per cent of cases of gall-stones which are limited purely to the gall-bladder; but when migration of the stones into the main ducts takes place the incidence rises to 60 per cent. In some patients with gall-stones the symptoms may be vague and signs may be entirely absent. In such anomalous cases nausea, frequent headache, "rheumatic pains," chiefly felt in the neck, in the back and in the joints, are complained of. This is a manifestation of a chronic toxæmia and it is extremely difficult to trace the trouble to the gall-bladder. Nevertheless, when the presence of chronic cholecystitis is proved conclusively and cholecystectomy is undertaken, in the majority of cases the rheumatic manifestations disappear.

In some patients, too, cardiac symptoms—precordial pain, palpitation, breathlessness—are much in evidence. It would appear that the myocardium becomes secondarily affected by prolonged biliary disease, and severe cardiac pain may occur, closely simulating angina pectoris. This condition has been termed the "cholecystitic heart" and is no bar to operation.

Not infrequently, as Miller (*Lancet*, 1:767, 1932) has pointed out, the cardiac condition improves considerably after cholecystectomy. Laird (*Lancet*, 1:884, 1938) considers that chronic cholecystitis is associated with cardiac lesions in over 70 per cent of cases and that in the majority of them excision of the gall-bladder will effect a cure.

In the quiescent period physical examination of the abdomen will often be negative, although Murphy's sign may be positive. Following an attack of biliary colic there may be some rigidity and tender-

ness in the right upper quadrant of the abdomen, but apart from this little else can be discovered.

Diagnosis. As a rule, chronic cholecystitis can be diagnosed on the symptoms alone, as they are strikingly characteristic. But at times the disease may be confused with chronic appendicitis, chronic peptic

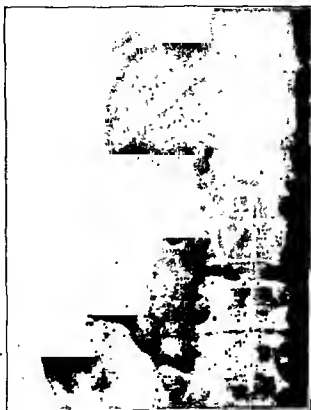


FIG. 165.—SOLITARY OPAQUE STONE IN THE COMMON BILE DUCT.

At operation the stone was found to be occupying the ampulla of Vater (Vilvandre).

ulcer, simple dyspepsia, carcinoma of the colon, chronic pancreatitis, or renal disease. An accurate diagnosis is often achieved by employing the following tests:

1. Straight X-ray of the gall-bladder region.
2. Cholecystography.
3. Barium meal.

4. Duodenal drainage.

5. Complete examination of the blood and excreta.

A straight X-ray film will demonstrate the presence of stones in some 10 per cent of the cases investigated. Stones in the common bile duct rarely throw a shadow (fig. 165), but the barrel-shaped stones in the gall-bladder, which often have an outer shell of calcium, the so-called "signet ring" stone, with its cholesterol core and coating of calcium bilirubin, and calcium carbonate stones, are easily recognised in flat skiagrams (figs. 166, 167, 168 and 169).

Cholecystography is now universally used and the profession owes a great debt to Graham and Cole (*J. Am. M. Ass.*, 82:613, 1924) for the introduction of this valuable test. It consists of giving sodium tetra-iodophenolphthalein by mouth or by the intravenous route. The dye is excreted in the bile and is carried to the gall-bladder and there concentrated. The concentrated dye, being radiopaque, clearly outlines the gall-bladder. The test is a gauge of gall-bladder function. It determines the presence or absence of stones, and also determines the character, number and position of the stones. It is also valuable in differentiating gall-stones from other calculi in the right upper abdomen which might otherwise be misinterpreted.

I have said that this test determines the number of gall-stones in the gall-bladder, but this statement requires qualifying, since at times many more gall-stones may be present than is suggested by the X-ray pictures. The dye should not be given to patients who are jaundiced, as it is then not free from danger. Dick and Wallace (*Brit. J. Surg.*, 15:360, 1928) pointed out that where a stone is impacted in the



FIG. 166.—STRAIGHT X-RAY OF A GALL-BLADDER IMMEDIATELY AFTER IT HAD BEEN REMOVED, SHOWING THE GALL-BLADDER AND CYSTIC DUCT TIGHTLY PACKED WITH SMALL MULTIPLE FACETED STONES.

ampulla of Vater it may throw the common bile duct and pancreatic duct into direct communication, and if the dye is given it may light up an acute hæmorrhagic pancreatitis with fatal consequences.



FIG. 167.—"SIGNET-RING" GALL-STONE.

The dye is given by mouth during the preceding evening on an empty stomach, the usual dose being 0.04 to 0.16 gm. per kilogram of body weight up to 75 grs. If the dye is given intravenously not more than 3 gms. (45 grs.) should be injected. After the dye has been taken, all food should be prohibited. Skiagrams are taken in the morning, and if a shadow is present a fatty meal is given to see if the gall-bladder contracts uniformly.

Interpretation of Cholecystograms. 1. Normal gall-bladder. Here there is a good uniform shadow of the gall-bladder, which contracts satisfactorily after a fatty meal (figs. 170 and 171). It indicates definitely that the liver is capable of excreting the dye, that the bile ducts are patent, and that there is no impairment of the walls of the gall-bladder.

2. The gall-bladder outlines well, but contains negative shadows; this implies that the dye-laden bile has freely entered the gall-bladder, the walls of which may or may not be chronically inflamed, and that

the negative shadows are caused by non-opaque gall-stones which have displaced the dye (fig. 172).



FIG. 168.—STRAIGHT X-RAY OF GALL-BLADDER REGION, SHOWING MULTIPLE FACETED STONES OF THE "SIGNET-RING" TYPE (LAURIE).

3. No gall-bladder shadow. This means that the cystic duct is blocked and that the gall-bladder is pathological. In such cases an intravenous injection of the dye should be given and if no shadow shows up after this it is additional confirmation that the gall-bladder is diseased.

4. A faint gall-bladder shadow. These are the most difficult cases to assess correctly. If the shadow is faint and contraction poor, all

would agree with Scott and Moore (*Am. J. Surg.*, 40:157, 1938) that this is indicative of early disease, possibly cholesterosis. Kirklin (*Surg. Clin. N. Am.*, 19:913, 1939) states that faintness of the shadow is not a very reliable index of biliary disease since the personal equation necessarily enters into this interpretation. However, if the designation "faint" is restricted to a shadow so delicate that it is hard to discern, the faint shadow is logically attributable to impairment of

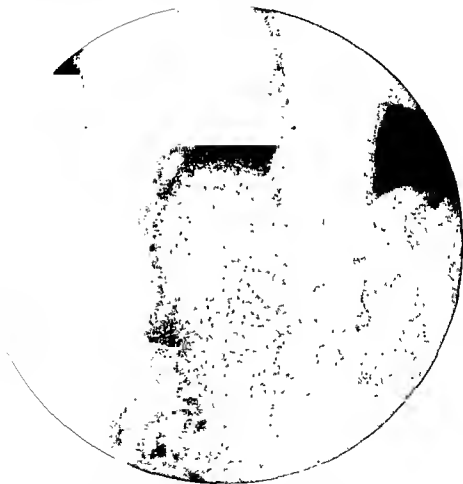


FIG. 169.—MULTIPLE GALL-STONES.

Graham's dye was given orally, but the gall-bladder did not fill with opaque medium. Operation showed stones in the gall-bladder and common duct, and a small growth 2 cms. in diameter in the fundus, growing into the lumen. Microscopical section revealed a well-differentiated adenocarcinoma of the gall-bladder (Laurie).



FIG. 170.—NORMAL CHOLECYSTOGRAM.



FIG. 171.—SAME GALL-BLADDER AS ILLUSTRATED IN FIG. 170, AFTER THE ADMINISTRATION OF A FATTY MEAL.

The gall-bladder has contracted satisfactorily.

function by disease, and less than 7 per cent of diagnoses having such a basis will prove to be erroneous.

5. Gall-bladder irregular in outline. There may be filling defects suggestive of papillomatous growths. This is well illustrated in figure 148.

In some patients with perfectly healthy gall-bladders no gall-bladder shadow may be obtained if the patient fails to co-operate. For instance, he may partake of a hearty meal after swallowing the



FIG. 172.—CHOLECYSTOGRAM SHOWING TWO SMALL NEGATIVE SHADOWS WHICH ARE CAUSED BY NON-OPAQUE GALL-STONES (BULL).

dye; the dye may be vomited and this fact not be reported; while in some instances, although the dye is taken, it may not be absorbed from the alimentary canal, as sometimes occurs in cases of marked gastritis or where there is diarrhoea. Where there is defective liver function, such as in cirrhosis, insufficient dye may be excreted to throw up a shadow.

Barium Meal. A barium meal examination of the stomach and duodenum and possibly the colon is desirable to exclude the presence of concomitant disease such as duodenal ulcer, chronic appendicitis, etc.

Duodenal Drainage. This consists of passing a duodenal tube, and after ensuring that the point of the tube is lying in the duodenum, running in a concentrated solution of magnesium sulphate through the tube. After a little while the bile is recovered from the duodenum and examined. In marked disease of the gall-bladder and bile passages, biliary sand, pus cells and organisms may be recovered. A negative finding is of no value, as normal bile may be obtained even in the presence of calculous cholecystitis. The Meltzer-Lyon test is of real value in diagnosis and in assessing the effects of medical treatment in those cases where the common bile duct is especially infected.

Treatment. There is little doubt that a large number of patients with early chronic cholecystitis can be rendered symptom-free by careful dieting and efficient medical treatment. In a well-established case, however, operation is clearly indicated as the disease is indolent and the organisms which are lodged in the walls of the diseased gall-bladder are difficult or impossible to destroy by medical measures and constitute a focus of infection which produces metastatic toxic effects upon distant organs and tissues (Wilkie, *Practitioner*, 128:113, 1932).

The diseased gall-bladder is responsible for many disagreeable dyspeptic symptoms and much ill-health and is a potentially malignant organ. In addition to this, chronic cholecystitis is very often associated with gall-stones, and the serious complications which result from their migration or impaction are by no means infrequent.

All available statistics prove quite conclusively that the ideal treatment for a case of chronic cholecystitis is removal of the diseased and crippled gall-bladder. Cholecystostomy is reserved for those *very few* cases in which excision would appear too hazardous or where the patient's condition warrants only the simplest procedure possible in the circumstances. It is indeed a poor alternative to cholecystectomy. The difficult cases are those in which the patient gives a definite history of flatulent dyspepsia, recurrent attacks of biliary colic and of other symptoms indicating disease of the gall-bladder, in which a Graham dye test has given no gall-bladder shadow or at best a very faint one, and where at operation the gall-bladder appears to be healthy. In cases such as these, where there is no evidence of chronic appendicitis, gastric or duodenal ulcer, or any other intra-abdominal lesion, it is better to remove the gall-bladder than to compromise by

draining it or by leaving it in situ. Cholecystostomy in such cases is, in my experience, quite futile. Such gall-bladders, when removed and examined, will often show a mild degree of chronic cholecystitis or will be found to be the seat of cholesterosis.

Stones in the Common Bile Duct. Gall-stones may pass from the gall-bladder through the cystic duct into the main bile passages, and in cases of chronic cholangitis associated with stasis of the bile ducts putty-like pigment masses may accumulate in the ducts.

In what percentage of cases of calculous cholecystitis are stones found in the common bile duct? Crump (*Surg., Gynec. & Obst.*, 53:447, 1931), in a post-mortem study of subjects between the ages of 11 and 94, collected 325 cases of calculous cholecystitis and found that 78 (24 per cent) of these were associated with stones in the biliary passages. Lahey (*New England J. Med.*, 215:1275, 1935) analysed 1,800 operations for gall-stones which were performed at his clinic in Boston. In these the ducts were explored and drained for stone in 531 (30 per cent) and common bile ducts stones were found and removed in 258 (15 per cent). In a later series (1938) stones were found and removed from the common bile duct in 20 per cent of the cases. The lodging of a calculus in the common bile duct is therefore of fairly frequent occurrence and is a grave complication of gall-stones.

Clinical Features The clinical features of stone in the common duct are best discussed under the following headings:

1. Typical cases—intermittent obstruction.
2. Complete obstruction.
3. Atypical cases.

In a *typical* case there will be a long history of flatulent dyspepsia suggestive of gall-stones, and with this are associated attacks of colic. The attacks of colic are followed in a few cases by the onset of jaundice which may last for many hours or days and then gradually subside. The attacks tend to become more frequent and more severe. The duct dilates and becomes infected, while at a later stage biliary mud silts up or lines the duct and coats the stones, thus adding to their bulk. Charcot's syndrome is an indication of a severe grade of obstruction and cholangitis. It consists of intermittent attacks of right hypogastric and epigastric pain, intermittent fever, rigors, jaundice with clay-like stools and bile-laden urine, associated with prostra-

tion, loss of weight and dehydration. If the obstruction is not relieved, death will ensue from suppurative cholangitis and liver abscesses.

When the stone becomes firmly impacted leading to *complete obstruction* of the common bile duct, the patient will give a history of a severe seizure of epigastric pain and this may or may not be associated with fever. After a few hours jaundice develops and deepens until a bright orange colour tints the skin and conjunctivæ. The grey-green colour characteristic of the complete jaundice of cancer of the head of the pancreas is rarely seen, as the blockage of the duct by a stone is seldom absolute and unrelenting. In the late stages there may be distressing itching, but here again this is seldom so pronounced as in a case of total occlusion of the duct such as obtains in cancer. It should be noted that loss of weight may be very marked, and is therefore no indication that the obstruction is due to a malignant lesion.

In an *atypical* case of stone in the common bile duct the patient may give a history which is in every way similar to that of a perforating simple ulcer of the first portion of the duodenum. He may deny ever having had severe pain or colic. There may be no bouts of chills and fevers, and there may be no attacks of jaundice. I would estimate that some 20 per cent of cases do not have biliary colic and that fully 40 per cent do not show any evidence of jaundice.

Signs of Impaction. On examination the patient is drowsy and depressed. Jaundice will be evident, the liver is enlarged, firm and tender, while in the majority of cases the rounded pyriform fundus of the gall-bladder is impalpable.

Diagnosis. The diagnosis may be very simple or again it may be obscure. In obstruction of the common bile duct due to stone, the following points should be noted in making a diagnosis:

1. There is often a long history of biliary disease.
2. There are, as a rule, many attacks of colic, some of which may be associated with jaundice.
3. The jaundice is somewhat variable.
4. There is an occasional appearance of bile in the fæces.
5. The liver is enlarged and in most cases the gall-bladder cannot be felt.
6. The van den Bergh test shows a direct positive reaction.

Gall-stone obstruction of the common bile duct has to be distin-

guished from other conditions which cause blockage of the main bile passages, such as:

1. Conditions *inside the lumen of the duct*—mucus, blood clot, intestinal parasites, foreign bodies, etc.

2. Conditions *in the wall of the duct*—new growths, fibrous stricture as a result of stone or operative trauma, and primary sclerosing cholangitis.

3. Conditions *outside the wall of the duct*—chronic sclerosing pancreatitis, carcinoma of the head of the pancreas, carcinoma of the pyloric end of the stomach, and pressure on the duct from without by enlarged inflamed or malignant glands, by abdominal tumours, e.g., hydatid, or by a very large gall-stone in the gall-bladder.

In cases with mild jaundice and intermittent pyrexia, hæmolytic jaundice must be excluded. The absence of splenic enlargement, the presence of bile in the urine, the normal fragility of the erythrocytes, the normal reticulocyte count and a direct positive van den Bergh reaction will exclude hæmolytic jaundice. It should nevertheless be remembered that in over 60 per cent of cases of hæmolytic jaundice, pigment stones are found in the gall-bladder and extra-hepatic bile passages (page 802).

Treatment. All patients who are known to have or are suspected of having stones in the common bile duct and who are awaiting operation are given a routine course of treatment (page 753). If the stone is impacted and jaundice is present, many authorities recommend that operation should be postponed in the hope that the stone may pass through into the duodenum or become disimpacted and jaundice subside. It is also held by some that the risks of operation on these jaundiced patients are very considerable as cholæmia is marked, liver function is disorganised, and bleeding is most difficult to control. In my experience, however, the dangers of operation are but slightly increased by the presence of jaundice, provided that adequate pre-operative measures on the lines I have suggested have been instituted.

Delay in relieving obstruction may, and often does, lead to severe or even fatal complications; suppurative cholangitis may ensue or the liver may be irretrievably damaged from a severe long-standing back-pressure, and for these reasons I regard the onset of jaundice in a case of calculi as an indication for early operation. If the attack

has been mild and it is obvious that the jaundice is rapidly waning, it is wise to persevere with medical measures for a few days so as to obtain the maximum improvement in the patient's condition so that he may be able to withstand a carefully planned operation.

It must be emphasised that there is no standard operation for obstructive jaundice due to stone impaction of the common bile duct. In some cases the patient's condition is desperate and jaundice profound. Here, the obstruction must be relieved by the simplest measures. In others, where jaundice is slight and other factors appear favourable, the risks of such a major procedure as cholecystectomy combined with choledochostomy are relatively negligible. If there has been complete obstruction associated with deep jaundice and severe back-pressure on the liver, particularly if on aspiration the duct is found to be distended with white bile and the stone is firmly impacted, discretion will dictate simple T-tube drainage of the duct, leaving the removal of the stone or stones and the diseased gall-bladder to a second operation when jaundice is relieved and hepatic function restored.

It is of the greatest importance in the post-operative management of these cases to decompress the common bile duct very gradually by the method suggested by Raydin and Frazier (*Surg., Gynec. & Obst.*, 65:11, 1937). If the patient is in fair condition but jaundice is pronounced, and if on aspiration of the duct wholesome bile is withdrawn, the ducts should be explored, calculi should be extracted and T-tube drainage instituted. The gall-bladder should, in addition, be evacuated and drained. In these cases cholecystectomy is inadvisable owing to the difficulty in controlling the oozing which takes place from the denuded gall-bladder bed and from numerous vascular adhesions. If, however, on exploration the gall-bladder is found to be small, shrivelled and fibrous, and is surrounded by numerous adhesions which obscure the common duct, and an impacted calculus can be felt in the common duct, dissection of the structures over the duct should be limited to a minimum. In such cases as these Moynihan's method of rotation of the duct may be employed with great advantage for extraction of the stone.

When jaundice is slight or absent and the patient's condition is satisfactory, a deliberate operation can be carried out. The exposure here must be complete. All adhesions must be carefully divided and

dissection performed until the three ducts are clearly visible. The fundus of the gall-bladder and Hartmann's pouch are seized with artery forceps and pulled upward, the pylorus and duodenum are retracted downward with Deaver retractors, and the common bile duct is put on the stretch. Before opening the duct it is most essential to place a gauze pack underneath it into the foramen of Winslow to prevent any septic bile from reaching the lesser sac.

The field of operation is carefully packed off and an incision $1\frac{1}{3}$ inch long is made through the anterior wall of the common bile duct, just below the point where the cystic duct joins the two common ducts. The infected bile which wells up in the wound is removed by suction or rapidly mopped up, and the edges of the wound in the duct are retracted by two stay sutures. The forefinger and the thumb of the left hand are used as a guide and support, the stones are removed by scoops or forceps, and the patency of the papilla of Vater is established by passing a 5 mm. gum-elastic catheter or the tips of Desjardins forceps into the duodenum.

After removal of the stone or stones from the common duct, the papilla should be well dilated with graduated sounds, the largest being 9 mm. If the duct contains biliary mud, gravel or inflammatory debris, this should be removed by irrigating the duct with normal saline solution through a soft rubber catheter attached to a large Record syringe. Irrigation is continued until the fluid returns quite clear, all this returning fluid being removed by suction.

At the completion of the irrigation the gall-bladder is removed, and the common bile duct is drained by means of the author's T-tube. I often use a large open-ended metal suction tube for passing down the common duct to the ampulla where stones are so commonly overlooked, and this tube, which is attached to a suction apparatus, is most useful for removing all debris and even impacted stones. There is never any necessity to resort to *retro-duodenal choledochostomy* but on rare occasions *trans-duodenal choledochostomy* may be indicated. This operation, together with its indications, is discussed on page 793.

CHAPTER 4

THE TECHNIQUE OF OPERATIONS UPON THE GALL-BLADDER AND BILE DUCTS

PRE-OPERATIVE MEASURES

(A) **For Chronic Cholecystitis With or Without Gall-Stones in the Absence of Complications.** These patients are very carefully prepared for operation and all septic foci are eradicated. If there is marked obesity a systematic reduction in weight should first be effected by dieting and exercises. Such patients may often lose two or three stones (28 or 42 pounds) in the course of a few weeks or months, which besides considerably improving their general condition will also greatly facilitate the performance of the operation and will help to diminish the operative mortality. Thyroid extract may be administered in suitable cases. The following articles, which are rich in cholesterol, are best avoided: yolk of eggs in any form, including cakes and sweets made with eggs; cream, cheese, kidney, liver, sweetbread, brain, duck and goose; the fat of meat, suet, pork, sausages and high game. Butter and fats are restricted to a minimum. The administration of hexamine and Epsom salts for at least a week before operation and for a few days afterward not only makes the operation safer but greatly reduces the risk of post-operative complications, both immediate and remote. I am aware that the hexamine treatment has been criticised on the grounds that it is merely a disinfectant to the bile and can have no effect upon the intra-mural organisms which are so frequently found in cases of cholecystitis; nevertheless, there is little doubt that there are many cases of mild chronic cholecystitis which can be rendered symptom-free by means of biliary antiseptics and the stimulation of biliary drainage on the lines laid down by Hurst, and I have found this treatment very helpful in the management of patients awaiting operation and in the immediate post-operative period. This treatment may be outlined as follows:

1. *Hexamine*. The following mixture is given three times a day in water or milk: hexamine, grs. 100, sod. bic., grs. 60, sod. citrate, grs. 60. The irritation of the urinary bladder with doses of hexamine exceeding 60 grs. per day is due to formalin being set free by the acid urine. This can be prevented by rendering the urine alkaline. As hexamine acts as a biliary antiseptic in spite of the alkalinity of the bile, its efficacy is not reduced by giving alkalis, although preventing it from acting as a urinary antiseptic.

2. *Epsom Salts*. These should be taken in concentrated solution, fasting, one hour before breakfast every morning. The largest possible dose should be given short of causing troublesome diarrhœa, and no other aperient should be taken. This produces reflex contraction of the gall-bladder and bile ducts with relaxation of the sphincter of Oddi.

3. *Olive Oil*. Two tablespoonfuls of oil three times a day before meals has the same effect as Epsom salts.

4. *Anti-spasmodics*. Drugs, such as amylnitrite, nitroglycerine and atropin may be given to aid the expansion of the sphincter of Oddi and thus ensure a free flow of bile into the duodenum.

5. *Cholagogue*. A cholagogue such as the Vincent-Lyon pill may be prescribed with benefit. This is composed as follows: Sod. oleat., grs. 3, sod. glycochol., grs. 3, sod. salicyl., grs. 3, ol. pip., mm. 1, excipient q.s., one pill three times a day after meals.

(B) *For the Jaundiced Patient*. These measures are as follows:

1. *Water, salts and glucose*. If the patient is capable of taking large quantities of fluids and glucose by mouth, the position is very much simplified. From 5 to 10 pints of fluid nourishment, which would include barley water, tea, coffee, fresh lemon, lime or orange juice freely sweetened with glucose, etc., should be given each day for two or three days before operation. If sufficient amounts of fluid cannot be taken by mouth, then plain tap water by proctoclysis will serve adequately in most cases. The intravenous drip method, in which Ringer's or Hartmann's solution and 5 to 10 per cent glucose is administered, is excellent in maintaining water balance, in combating cholæmia, in restoring the function of the liver and in flushing out the kidneys.

2. *Coagulation time of the blood*. The following measures have been widely used to decrease the coagulation time of the blood:

(a) Intravenous injections of 5 cc. of 10 per cent calcium chloride or 10 cc. of a 10 per cent solution of calcium gluconate given intravenously daily on three consecutive days (Mayo-Robson, Waltman Walters, Whipple and others); (b) 30 cc. of a 30 per cent solution of sodium citrate injected intramuscularly immediately before operation (Wilkie); (c) blood transfusions. Small whole blood transfusions are given before and after operation. It is my practice to prescribe 10 oz. of whole blood a few hours before operation and again shortly after the patient has returned from the theatre; (d) auto-hæmotherapy; 10 cc. of blood is withdrawn from the patient's arm and injected into the gluteal region once daily for three days, but I am very doubtful whether this measure is of any real value.

3. *Vitamins*. Vitamin deficiencies are corrected by prescribing fat-soluble vitamins A, D and K, and water-soluble vitamin C. There are a large number of excellent proprietary preparations now available which combine all these vitamins in an easily administered form. The value of vitamin K has again recently received special mention from Quick (*J. Am. M. Ass.*, 110:1658, 1938). McNally (*Tr. Internat. Coll. Surg.*, 1:1, 132, 1938) considers that the easiest way to restore a low prothrombin level and supply vitamin K is to give whole blood transfusions. In order to facilitate the absorption of these fat-soluble vitamins it is essential to give animal bile salts, 5 to 10 grs. by mouth three times a day. Vitamin C is the water-soluble anti-scorbutic element which occurs in fresh food stuffs—fruit juice and vegetables, and is also found in comparatively small amounts in fresh milk and raw meat juice. Lemon, lime, or orange juice, sweetened with glucose, will make good any deficiency of vitamin C if the patient can take food by mouth. If, however, parenteral administration is necessary, it may be introduced subcutaneously daily in doses of 0.025 to 0.050 gm. of cevitamic acid until a normal blood level is reached.

4. *Cylotropin*. In cases of jaundice associated with acute suppurative cholangitis I have found intravenous injections of cylotropin (Schering) efficacious, as it often has a marked effect in lowering the temperature and in diminishing jaundice. In a severe case 5 cc. is injected intravenously daily for the first three days, after which 5 cc. is injected on alternate days. It is important to warm the ampoule up to blood heat and to inject the solution very slowly.

GENERAL CONSIDERATIONS

Instruments. Some of the more important instruments which are used in gall-bladder surgery, such as Deaver or Curvite retractors (four sizes—small, medium, large and extra large); long dissecting (non-toothed) forceps (15 inches); Moynihan's cholecystectomy

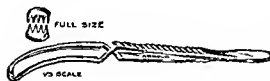


FIG. 173—SCOTT RIDOUT FORCEPS.

forceps; W. J. Mayo's trocar and cannula; T-tubes (Kehr's pattern in different sizes, and the author's gutter T-tube); gum elastic bougies and pliable lead dilators (in sizes from 3 mms. to 9 mms.);

various scoops; suction tubes; Desjardins forceps; Scott Ridout tetra forceps, etc., need no special description (fig. 173).

2. The Position of the Patient on the Operating Table. It is advantageous to insert a tripartite rubber bag under the lower ribs or to elevate the bridge which is present in some operating tables so as to arch the body slightly and throw out the epigastric region, thus bringing the lower edge of the liver and gall-bladder forward. The head should be slightly flexed, a sandbag should be placed underneath the knees, and the table should be tilted to about 15 degrees in a slightly reversed Trendelenburg position. This position greatly facilitates the exposure of the gall-bladder and bile ducts, which can be brought almost to the level of the abdominal wound, and the intestines as they sink downward toward the pelvis do not protrude into the operative field. Marked hyperextension of the body is to be avoided as it tends to cause respiratory embarrassment and chest complications.

3. Incisions. There are a large number of incisions which have been employed in the surgery of the gall-bladder and bile passages. These include the median vertical epigastric, paramedian, muscle-split, the Bevan S-shaped, Mayo-Robson, Kehr, transverse and Kocher subcostal. In actual practice I only employ two incisions: the paramedian, in which the upper half of the right rectus muscle is retracted outward, and Kocher's incision. I prefer the paramedian incision in thin patients or where the costal angle is very narrow. Kocher's incision is employed for all other cases and is especially

suitable for obese patients. For secondary operations also, or where there has been a previous paramedian or muscle-split incision, Kocher's subcostal incision would be the one of choice. This starts just below the tip of the xiphisternum and proceeds downward and outward for 4 or 5 inches, $1\frac{1}{2}$ inches below the right costal margin. In order to give ample access it is essential to divide the right rectus muscle completely. After the skin incision has been made, the muscles and extraperitoneal tissues are infiltrated with 0.5 per cent of novocaine solution in order to facilitate the division of the muscles of the lateral abdominal wall and to aid relaxation. The eighth and ninth dorsal nerves will be encountered at the outer border of the rectus muscle. It is often impossible to save the small eighth nerve, but the larger ninth nerve must be dissected out for an inch or two and carefully preserved.

At the completion of the operation, to permit of easy suture of the wound, the bridge of the operating table is lowered or the tripartite bag is removed. The edges of the peritoneum, the posterior sheath of the rectus muscle and the fleshy fibres of the transversalis muscle are drawn together with a continuous suture of No. 0 twenty-day chromic catgut, using a double strand of this material. The anterior sheath of the rectus muscle and the edges of the external and internal oblique muscles are drawn together with interrupted sutures of No. 0 twenty-day chromic catgut. The skin is closed with vertical mattress sutures of fine deknatel or silk. As a rule no tension sutures are employed for Kocher's incision. Occasionally, however, in very obese patients and where speed is imperative owing to the patient's grave condition, all the layers of the abdominal wall may be approximated with a series of through-and-through sutures of stout silk or bronze, silver or stainless alloy steel wire (Babcock, *J. Am. M. Ass.*, 102:1756, 1934). When the patient is obese, in order to facilitate exposure of the ducts and to make all intra-abdominal manipulations easier the incision through the skin and subcutaneous tissues is made very much longer than that through the muscles.

OPERATIVE PROCEDURES

The following operations will now be described:

1. Cholecystostomy.

2. Cholecystectomy and partial cholecystectomy.
3. Electro-surgical obliteration of the gall-bladder—Max Thorek's operation.
4. Cholecystectomy.
5. Cholecystectomy, exploration of the bile ducts, and choledochostomy for calculous cholecystitis.
6. Moynihan's operation of rotation of the common bile duct followed by choledochostomy.
7. Lateral choledochoduodenostomy.

Cholecystostomy. The main indications for the performance of this operation may be summarised as follows:

1. Acute or chronic cholecystitis with or without gall-stones: (*a*) When the patient is very aged and infirm; (*b*) when cholecystectomy presents unusual technical difficulties or involves great risk; (*c*) when the condition of the patient is grave, toxæmia being pronounced or other complications present.
2. As an additional therapeutic measure in certain cases of acute pancreatic necrosis.
3. As a preliminary measure in certain cases of acute cholecystitis and suppurative cholangitis associated with obstruction of the common bile duct.
4. As a first-stage operation in certain cases of chronic sclerosing pancreatitis associated with jaundice and of cancer of the head of the pancreas.

The edges of the wound and the region around the gall-bladder should be well protected with abdominal pads and mackintosh or cellophane squares, as the bile is often highly infective in cases in which cholecystostomy is performed. Inflammatory adhesions, and in particular inflamed œdematous omentum which is walling off the gall-bladder, should be disturbed as little as possible. If the gall-bladder is enlarged, a mackintosh sheet with a hole of sufficient size to admit the fundus is taken and fitted snugly around the gall-bladder, where it is fastened by Allis forceps, thus taking all available precautions to isolate completely the site of the intended cholecystostomy from the remainder of the operative field.

The contents of the gall-bladder are next aspirated with a wide-bore aspirating needle attached to a large Record syringe, or if the

gall-bladder is unduly distended the isolated fundus may be pierced by the Mayo trocar and cannula and the infected bile withdrawn into a receptacle by suction.

The fundus is now seized with Allis forceps on either side of the puncture spot to prevent the gall-bladder from retracting when it is empty and also to prevent any leakage when the needle or trocar is withdrawn. An incision of sufficient length to admit the finger is then made through the fundus, a suction tube is introduced into the gall-bladder, and the septic bile and inflammatory debris are withdrawn or the contents may be mopped up with gauze strips. The gall-bladder should now be empty and collapsed unless its walls are thickened and rigid with inflammatory exudate or stones occupy its interior. The index finger of the left hand is then passed under the cystic duct and the neck of the gall-bladder and the stones are worked upward with the fingers toward the opening in the fundus. The calculi may be expressed through this opening or be extracted from the gall-bladder with special scoops or forceps (fig. 174 [A]). When no further stones can be palpated either in the cystic duct or in the gall-bladder, the forefinger of the left hand is introduced into the gall-bladder to feel if any fragments or grit remain; if so, these may be removed by passing strips of gauze into the gall-bladder with dissecting forceps and by packing the gauze strips firmly in and then withdrawing them. Small particles will become entangled in the gauze meshes and can then be extracted. If there is much inflammatory debris or pigment putty-like substance, the gall-bladder should be gently irrigated with warm antiseptic solution by means of a rubber catheter attached to a syringe. The returning fluid should be mopped up or aspirated at once with a suction tube.

When calculi are felt to be firmly impacted in the cystic duct it is usually possible to milk them back into the gall-bladder. This is done by passing the finger and thumb of the right hand down and along the outer side of the neck of the gall-bladder until the finger tip enters the foramen of Winslow. In this way the lowest part of the cystic duct is reached. From this point the fingers are worked gently upward, pushing any stones which may be encountered back into the gall-bladder. If a stone is firmly lodged in the cystic duct, firm pressure is applied with the finger and thumb to its lower end, thus coaxing it back into the gall-bladder. If the stone cannot be dis-

lodged or if the cystic duct or neck of the gall-bladder is inadvertently torn during this manœuvre, cholecystectomy should be carried out.

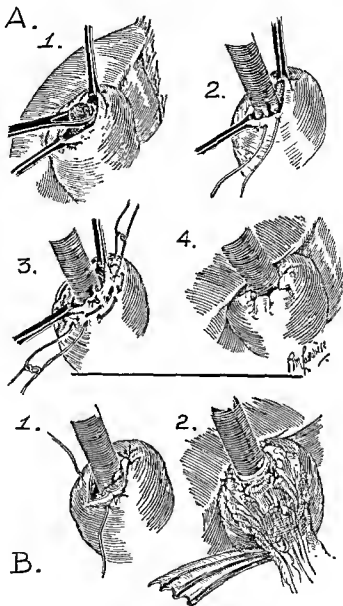


FIG. 174.—CHOLECYSTOSTOMY.

When the surgeon has made quite sure that no more stones remain in the gall-bladder and that the cystic duct is patent, a rubber tube with an outside diameter of about one-third of an inch to half an inch is passed for 2 to 3 inches into the gall-bladder and secured by a

stitch at the opening (fig. 174 [A2]). This stitch when tied anchors the rubber tube to the gall-bladder and further tends to invaginate a portion of the edge of the opening.

The incision in the gall-bladder is now closed by a series of interrupted sutures or by means of one or two purse-string sutures (fig. 174 [A3]). When the walls of the gall-bladder are very thick or friable, interrupted sutures will have to be used (fig. 174 [B1]); but when, on the other hand, the walls are flexible and firm, purse-string sutures are to be preferred (fig. 174 [A4]). Adjacent omentum is next brought up and wrapped around the tube or stitched to the fundus to afford assurance against leakage (fig. 174 [B2]). Another rubber tube, a piece of corrugated rubber or a Penrose drain is then placed below the gall-bladder in case there is any leakage, and the abdominal wound is closed.

Cholecystectomy and Partial Cholecystectomy. To recapitulate, the indications for cholecystectomy are:

1. Most cases of traumatic rupture of the gall-bladder.
2. Carcinoma of the gall-bladder. Here the operation often involves a wedge-excision of a portion of the liver.
3. Innocent new growths of the gall-bladder.
4. Most cases of internal or external biliary fistula, and especially mucus fistula following cholecystostomy.
5. Cholecystitis with or without gall-stones: (a) strawberry gall-bladder; (b) mucocele of the gall-bladder due to stone impacted in the neck of the gall-bladder or in the cystic duct; (c) most cases of chronic cholecystitis; (d) most cases of acute cholecystitis in the absence of complications; (e) volvulus of the gall-bladder; (f) empyema of the gall-bladder; (g) gangrene of the gall-bladder.

Partial cholecystectomy may be advised in certain cases where gangrene is limited to the fundus and body of the gall-bladder. By one method the separation commences at the fundus, but no attempt is made to dissect out the cystic duct or to identify the important structures in that region. The dissection and mobilisation proceed no further than the neck of the gall-bladder and very often only to a point proximal to this. Here two pairs of Kocher forceps are applied transversely side by side to the freed gall-bladder which is divided between them and removed. The remaining stump is partially closed by a few interrupted mattress sutures which are introduced in such

a way as to control bleeding. A rubber tube is inserted toward the cystic duct, through that portion of the gall-bladder which is not closed by the sutures. This tube is stitched into position. A corrugated rubber drain is laid down over the suture line and led out through the abdominal incision.

The method suggested by Estes (*Am. J. Surg.*, 40:197, 1938), which is associated with a 2 per cent post-operative mortality, is perhaps simpler and safer than the plan just described. After aspirating the gall-bladder, the fundus is incised, stones and débris are removed, the mucous membrane is thoroughly swabbed with iodine, and the gall-bladder is then slit open with scissors down to within $\frac{1}{2}$ inch of the cystic duct. The gall-bladder is next partially removed by trimming off the redundant part of each half down to the border of the liver fossa, leaving that portion attached to the liver. The bleeding from these cut edges is controlled by a continuous lockstitch which is placed on each side. Two or three cigarette drains are now placed about the cystic duct and brought out against the remnant of the gall-bladder to hold it open. The great omentum or the thickened gastro-colic omentum is placed against the drains to separate them from the nearby viscera.

The operation is completed by bringing the drains out through the abdominal wound, which is closed in the usual manner.

Electro-surgical Obliteration of the Gall-Bladder—Max Thorek's Operation. I am indebted to Dr. Max Thorek, Professor in Clinical Surgery at the Cook County Graduate School of Medicine, Chicago, for the following account of his well-known and highly successful operation. He writes:

Rationale. Removal of the gall-bladder yields in competent hands a mortality of about 1 or 2% in uncomplicated cases. The mortality increases with age and is greater in males than in females. Generally, in unselected cases, it ranges around 10%. In 15-25% of individuals enlarged bile capillaries and small bile ducts are found in the gall-bladder bed which cause bile leakage when the gall bladder is removed from its bed with the scalpel.

A properly ligated cystic duct does not leak; bile usually issues from the gall bladder bed. Bakes observed bile discharges from the wound 230 times in 346 cases of simple cholecystectomy. He was impressed by the post-operative appearance of bile in the dressing "in nearly all the cases."

After classical cholecystectomy the gall-bladder bed cannot always be obliterated by sutures. Drainage invites leakage. Open, unprotected bile and blood

channels in the gall-bladder bed offer a favourable atrium for the entrance of micro-organisms.

Drainage causes trouble in a number of ways (augmentation of bile seepage; thrombosis and embolism; hæmorrhage from erosion of vessels; cholæmic bleeding; embarrassed cardiac action, particularly in the aged; pneumonia; acute dilatation of the stomach; biliary fistulae, etc.). Many patients die after gall-bladder operations not because they were not drained but because of drainage. Though many dangers may be eliminated by omitting drains, drainage nevertheless instituted following classical cholecystectomy may be the means of saving a life. In classical cholecystectomy one should resort to what Lord Moynihan so aptly termed a "conscience drain."

Experimental studies on dogs and monkeys proved that bile leakage can be prevented by electro-coagulation. When properly performed, this converts the tissues into a hyaline-like, dry, aseptic, inert tampon. Unfortunately, electro-coagulation is still confused by many with fulguration and carbonisation, which are entirely different in their action and effects. If a flat electrode of a bipolar current is firmly applied to a tissue surface and a current of proper voltage and sufficient amperage is permitted to pass through it, dehydration and coagulation of the tissue-proteins result in a few seconds and the tissue turns white. If the electrode is not applied firmly or if it is used as a unipolar instrument, a small air-space (dielectricum) intervenes between the tissue and sparking, fulguration, and carbonisation with black discoloration of the tissue surface results. A re-application of the electrode to such fulgurated or carbonised surface will stop further current-penetration and prevent coagulation from taking place. In cauterisation the heat is brought to the tissues from the outside by the heated instrument, whereas in bipolar or short-wave electro-coagulation the heat is produced in the patient's body.

Electro-coagulated surfaces on parenchymatous organs develop an affinity for serous surfaces, attracting contiguous organs covered with serosa (omentum, stomach, bowels). Agglutinations have been observed three hours after electro-coagulating the surface of the liver. Firm union takes place in a comparatively short time. *Capillaries and blood vessels of an electro-coagulated area do not thrombose.* The vessel walls are converted and coalesce with the contiguous, homogenous, hyaline-like structures mentioned.

Electro-coagulation of the tissues in the gall-bladder bed frustrates secondary hæmorrhage because of the pressure exerted by the sequestered, coagulated segment against the contiguous tissue. Thus, electro-coagulation substitutes a secure sterile tampon for an insecure open cavity at the site of the gall-bladder bed, resulting from classical cholecystectomy.

OPERATIVE TECHNIQUE

Step 1. In well-trained hands, subarachnoid block is the anæsthetic of choice; otherwise, inhalation anæsthesia is administered. The patient is placed in the Mayo-Robson position with the lower thorax and upper abdomen sufficiently

elevated. When the biterminal apparatus is used, a large, flat, indifferent electrode is snugly applied over the sacrum. Where short-wave is used, an indifferent electrode is not necessary. A straight longitudinal paramedian incision or transverse incision is used.

Step 2. The falciform ligament is completely detached from the anterior abdominal wall and is placed in a receptacle containing warm normal salt solution. In detaching the falciform ligament from the anterior abdominal wall, some small vessels are severed; these must be carefully ligated. The viscera are packed out of the way. Good exposure by efficient retraction is essential.

Step 3. The gall-bladder is next aspirated. An especially designed aspirator which permits evacuation of the gall bladder contents into a receptacle via a rubber tube is used. After aspiration of its contents, the gall bladder is filled with hexylresorcinol or some other antiseptic solution. (Only about 5% of bile contains microorganisms, while their presence in the gall-bladder wall may be demonstrated in over 70% of cases. For that reason, an antiseptic is introduced into the gall-bladder before opening it.) If the cystic duct is patent the ducts may be explored. The frequently abnormal course of the cystic artery should be kept in mind.

Step 4. The gall-bladder is opened and its contents are evacuated. A gall-bladder content receptacle is used which collects the evacuated material without spilling it. This instrument consists of a cone-shaped container measuring $2\frac{1}{4}$ inches in diameter and 2 inches in depth, mounted on a shaft of suitable size. A close-fitting cover is hinged, and held open when in use by means of spring friction clips. Slight pressure upon the cover releases it so that the material cannot spill during its removal. The front part of the receptacle is somewhat concave, allowing sufficient latitude for proper contact with the sub-cholecystic structures, and its edges are rounded, thus avoiding injury to the liver.

Step 5. The gall-bladder is split longitudinally from above downward with an ordinary pair of scissors. Half of the gall-bladder wall is grasped with insulated angiotribe forceps and the gall bladder wall is crushed by compression. With an ordinary pair of scissors the redundant portion of the gall-bladder wall is removed (fig. 175 [1]). A small electrode firmly applied electrocoagulates the exposed margin of the gall-bladder wall held in the forceps (fig. 175 [2]). The smaller the electrode the quicker the action. After sufficient coagulation, the forceps are opened; a compressed coagulated ribbon of tissue remains. The procedure is repeated on the other half of the gall-bladder, and the remaining portion of the posterior wall of the attached gall-bladder is treated similarly (fig. 176 [3]). Quick decisive coagulation with firm electrode contact yields the best results. A current of low voltage and high amperage on a rather small electrode is best.

Prompt thorough dehydration and a sharply defined line of demarcation between the coagulated and non-coagulated tissue results. Tissue thus coagu-

lated will retain less moisture than tissue coagulated more slowly, and less heat is radiated to the contiguous structures.

Fulguration and its attendant carbonisation must be avoided because such carbonisation will defeat the purpose of the operation.



FIG. 175.—ELECTRO-SURGICAL OBLITERATION OF THE GALL-BLADDER—MAX THORPE'S OPERATION.

Step 6. The electro-coagulated edges of the gall-bladder are approximated with a few interrupted or a continuous suture of fine catgut. While thus approximating the edges without strangulating them, the needle carrying the

catgut must not penetrate the liver substance—only the edges of the coagulated ribbon are picked up.



FIG. 176.—ELECTRO-SURGICAL OBLITERATION OF THE GALL BLADDER—MAX THOREK'S OPERATION.

Step 7. The previously detached falciform ligament or a segment of omentum is now removed from the salt solution container and is sutured to the upper end of the united, coagulated gall-bladder bed (fig. 176 [4]). The lower third of the ligament is stitched to the lowermost end of the approximated electro-

coagulated surface and the free end of the ligament is placed, but not sutured, against the ligated end of the cystic duct and artery. An effective serous covering is thus formed over the gall-bladder bed and cystic duct. Two sutures are used as a rule, one above and one below.

Step 8. The laparotomy packs and retractors are removed; the field of operation is dried; and the abdominal wall is closed in the usual manner without drainage.

RÉSUMÉ

The method of electro-surgical obliteration of the gall-bladder described may be used in simple and complicated cases of gall-bladder disease without resorting to drainage. It strikingly reduces mortality ($\frac{1}{3}$ of 1%—980 cases).

The operation described must not be confused with mucoclasia practised with the cautery or with "diathermy fulguration" which aims at burning or carbonisation of the mucous membrane of the gall-bladder, or with the so-called "electrical" or "electro-cholecystectomy" where, instead of the scalpel the diathermy cutting knife is used.

A prerequisite to the achievement of satisfactory results is a patent common duct. An occluded cystic duct from any cause is an indication for this operation.

Where choledochostomy or hepaticostomy is indicated, the operation described may be done. The implanted falciform ligament over the obliterated gall-bladder bed forms sufficient protection and does not interfere with a common duct drainage tube.

Cholecystectomy. The gall-bladder may be removed by starting the dissection from the fundus or from the cystic duct end. When the dissection commences from the *fundus* end, the blood oozes from the raw surface of the liver and tends to obscure the field of operation, thus rendering the isolation of the cystic artery and duct extremely difficult. It is for this reason that I seldom employ this method. Nevertheless, when the gall-bladder is encompassed by dense adhesions, when an extra-large ovoid or barrel-shaped stone occupies Hartmann's pouch and by its bulk distorts and obscures the ducts, or when in some cases of acute cholecystitis these vital structures are hidden by œdematous peritoneal bands and membranes, rendering any dissection precarious, the plan of excising the gall-bladder by starting the dissection at the fundus end may be recommended. The technique is as follows: The fundus is seized with sponge or ring forceps or Dennis Browne forceps and retracted upward and outward, after which a Mayo trocar and cannula is plunged into the cavity of the gall-bladder (fig. 177 [1]). The cannula is attached to a suction apparatus and the gall-bladder is speedily emptied of its contents.

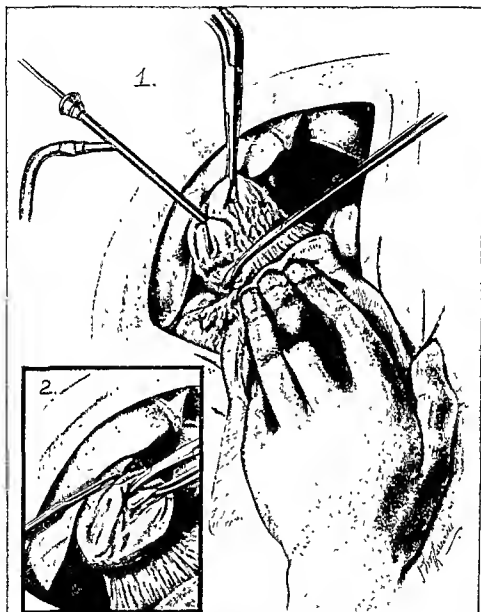


FIG. 177.—RETROGRADE CHOLECYSTECTOMY OR CHOLECYSTECTOMY STARTING THE DISSECTION FROM THE FUNDUS END.

On withdrawing this instrument the puncture hole in the fundus is immediately grasped in the jaws of artery forceps to prevent any leakage of bile during subsequent manipulations. The adhesions between the gall-bladder and adjacent viscera are cautiously sepa-

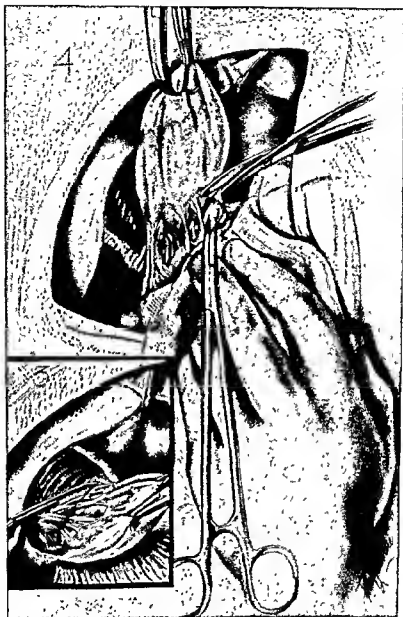


FIG. 178.—RETROGRADE CHOLECYSTECTOMY, STARTING THE DISSECTION FROM THE FUNDUS END.

Adhesions are being separated.

rated, as shown in figures 177 and 178, and the organ is gradually detached from its vascular bed by dissection with the point of a knife. When the neck of the gall-bladder is reached, great care must

be taken to isolate the cystic artery and to tie it in continuity close to the gall-bladder, using an aneurysm needle.

After dividing the artery, the fatty envelope around the cystic duct is dissected clear and the duct is traced to its junction with the common hepatic duct and the common bile duct. When these three ducts have been freed and displayed, an aneurysm needle threaded with a strand of silk is passed underneath the cystic duct and this duct is ligatured about $\frac{1}{4}$ -inch away from its junction with the main ducts (fig. 179 [5]). The portion of the cystic duct close to the neck of the gall-bladder is clamped with Moynihan cholecystectomy forceps and the duct is divided as close to the hæmostat as possible, using a knife the blade of which has been dipped in pure carbolic acid. A swab soaked in a hot saline solution is applied to the bleeding gall-bladder fossa for a few moments to control the oozing from this region, after which the raw area is reperitonised with a series of interrupted sutures, as illustrated in figure 179 (6).

Sometimes the margins of the gall-bladder fossa are so widely separated and the liver is so fatty and friable that it is impossible to close the defect by means of sutures. In such cases a substantial portion of the great omentum should be drawn into the wound in the liver and then plugged into this area and carefully sutured into position, or the ligamentum teres may be freed, drawn across the raw surface and held in place by a few stitches. The operative field is always drained, as there may be a considerable amount of oozing during the first day or two following operation.

In the *standard operation*, the cystic artery and cystic duct are displayed early on in the operation, and after these have been ligatured and divided the gall-bladder is freed from its bed in the liver and removed. The operation is greatly simplified by ensuring the maximum exposure of the gall-bladder and bile passages. This is obtained by: (1) an adequate paramedian or Kocher incision; (2) good illumination; (3) perfect anæsthesia; (4) carefully freeing any adhesions which may exist between the gall-bladder and adjacent viscera; (5) aspirating the contents of the gall-bladder; (6) grasping the fundus of the gall-bladder with ring forceps, Dennis Browne forceps or a large non-toothed hæmostat, and drawing the viscus firmly upward and outward. Rotation of the liver is not necessary; (7) inserting a long roll of gauze—and this may be as long as 5 to 10

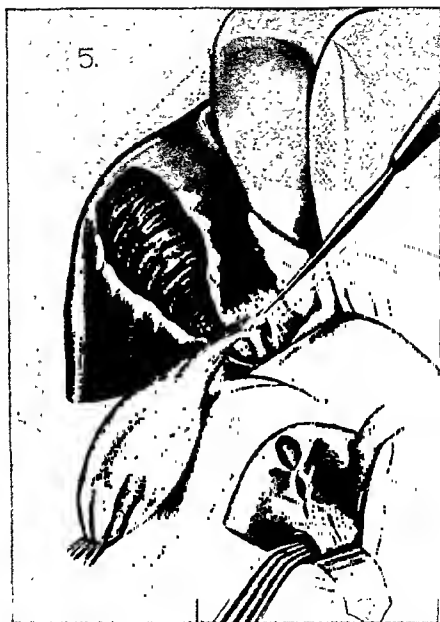


FIG. 179.—RETROGRADE CHOLECYSTECTOMY, STARTING THE DISSECTION FROM THE FUNDUS END.

In (5) the cystic artery has been isolated and ligatured, and the cystic duct is about to be tied; (6) shows the operation nearly completed.

feet—to act as a barrier between the pyloric end of the stomach, the first part of the duodenum, and the hepatic flexure of the colon on the one hand and the gall-bladder on the other. Morison's pouch is also filled with gauze. Two Deaver retractors are then inserted; one keeps the left lobe of the liver away from the operative field, while the other is slipped in between the neck of the gall-bladder and the duodenum, and when it is drawn downward it effectually keeps the duodenum out of the way and puts the common bile duct on the stretch. The placing of this roll into Morison's pouch between the gall-bladder and the duodenum and over the stomach and the correct placing of the Deaver retractors are all essential to good exposure (fig. 180). If the retractors have been correctly placed, the stomach, duodenum, colon and omentum are not seen throughout the essential steps of the operation.

Before the dissection commences, another long strip of gauze is passed into the foramen of Winslow to prevent blood or bile from reaching the lesser sac, and this is removed just before the operation is completed. A curved hæmostat is fixed to Hartmann's pouch (infundibulum). This is drawn downward, while the forceps on the fundus are pulled upward, thereby putting the cystic duct on the stretch so that this structure and the small triangular space above it in which the cystic artery lurks may be readily recognised (figs. 181 and 182).

A small incision is now made in the peritoneum over the neck of the gall-bladder, and the sero-fatty tissues in this region are cautiously dissected away until the whole length of the cystic duct can be clearly defined (fig. 182). The dissection now proceeds a little further inward in order to display the cystic artery and also the common bile duct, the common hepatic duct and the point where the cystic duct joins the common ducts.

I have already discussed the various anatomical points in connection with the cystic artery and how the right hepatic artery may be mistaken for it and be inadvertently ligatured. I feel sure that many of the so-called "liver deaths" or unexplained fatalities following straightforward cholecystectomy operations are due to ligature of the main hepatic artery or its right branch in mistake for the cystic artery. As a rule the cystic artery lies in a more posterior plane than the cystic duct, slightly above it and in close proximity to the liver.



FIG. 180.—CHOLECYSTECTOMY—THE STANDARD OPERATION.

The exposure.

A little dissection in this obscure area will reveal the artery travelling toward the gall-bladder. It must always be traced to the point where it actually enters the wall of the gall-bladder, usually near the neck. When it has been isolated, an aneurysm needle threaded with silk



FIG. 181.—CHOLECYSTECTOMY—THE STANDARD OPERATION.
Palpation of the common ducts.

or linen thread is passed behind it and tied in two places, well away from the right hepatic artery or its parent trunk, and as close as possible to the gall-bladder. The artery is then divided between the ligatures (fig. 183).

The cystic artery is a small vessel and should be handled gently and with the greatest care. Hæmostats are often clumsy instruments and they should certainly not be used to catch this delicate structure.

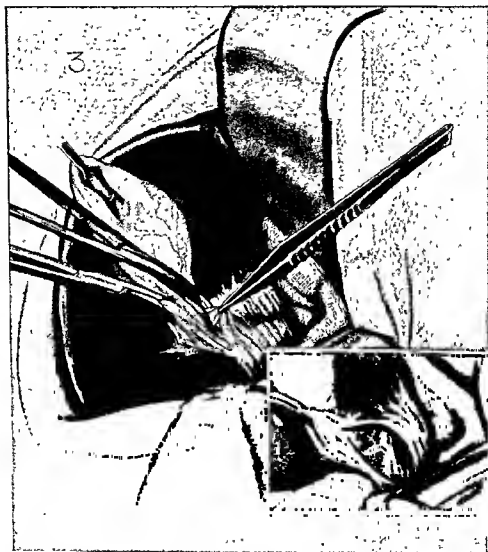


FIG. 182.—CHOLECYSTECTOMY—THE STANDARD OPERATION.

The three ducts are exposed.

The aneurysm needle method, as we employ it, ensures that neatness and tidiness which accompany precise work. The surgeon must always be on his guard when he sees an unduly large cystic artery. Here the



FIG. 183—CHOLECYSTECTOMY—THE STANDARD OPERATION.

Isolation, ligation and division of the cystic artery.

dissection cannot be too meticulous and the vessel must be cautiously freed to demonstrate its true anatomical relations. Too often what the surgeon considers to be a large cystic artery is, in fact, the right

hepatic artery. He should also proceed with circumspection when the right hepatic artery has a caterpillar-like hump or when it jostles the

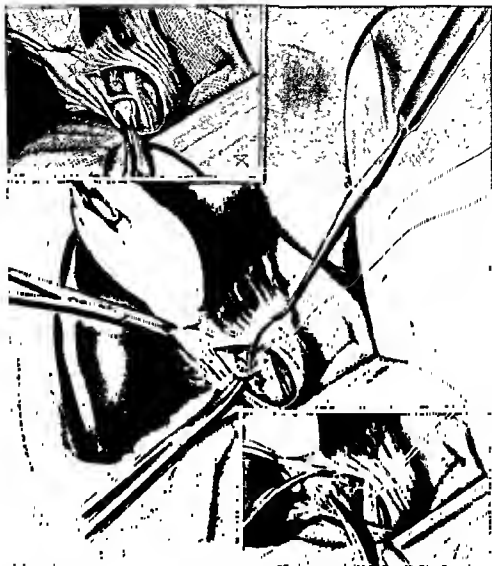


FIG. 184.—CHOLECYSTECTOMY—THE STANDARD OPERATION.

The cystic duct is isolated, ligatured and divided. cystic duct on its way to the right lobe of the liver, as the cystic artery in these cases is often stumpy, and cunningly hidden behind the neck of the gall-bladder.

It is, as a rule, better and safer to isolate and tie the cystic artery

before ligaturing the cystic duct; but if the artery is not readily identified or if it has an anomalous course or origin, it is, on the whole, wiser to deal with the cystic duct first, as when this duct is divided and drawn out of the way a wider and an unhampered dissection can be conducted in the cramped space in which the cystic artery lies.

The cystic duct is never ligatured until it has been followed upward into the neck of the gall-bladder and inward to the point where it unmistakably joins the common ducts, and it is a good rule at this stage to demonstrate to an assistant the three ducts as they are clearly displayed. The cystic duct is then rendered as taut as possible and an aneurysm needle threaded with a strand of silk or linen thread is passed underneath the duct, which is tied securely in two places (fig. 184). The duct is divided between ligatures, after which the neck of the gall-bladder close to the attenuated stump of the cystic duct is seized with curved artery forceps and rotated outward to display a small area of the posterior wall of the viscus so that any adhesions which may have developed here may be divided by sight (fig. 184).

As the separation of the gall-bladder proceeds upward the peritoneal reflections on either side are divided with a scalpel or a diathermy knife, and in order to facilitate the division of this peritoneal reflection saline or weak novocaine solution may be injected under the peritoneum where it is reflected from the gall-bladder on to the liver. The fluid lifts up the peritoneum all around the attached portion of the gall-bladder in a large diaphanous wheal and makes its separation a simple and bloodless procedure (Wilkie) (fig. 185).

A few large veins which are usually situated about the middle and on either side of the body of the gall-bladder are divided during this peritoneal separation, the bleeding points being picked up with mosquito forceps and ligatured. The gall-bladder fossa is covered over by stitching the cut edges of peritoneum together with a series of interrupted sutures, while the raw surface over the common ducts is likewise peritonised (fig. 186). Drainage of the sutured gall-bladder fossa is never omitted in this operation, as if bile escapes into the general peritoneal cavity it is prone to become infected and to give rise to septic peritonitis. The tube is left in situ for two or three days, as there may be leakage of bile from an unrecognised severed accessory hepatic duct or from the raw surface of the liver itself, and

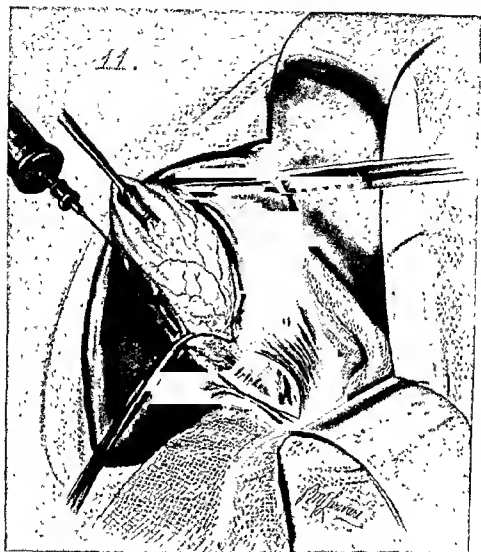


FIG. 185.—CHOLECYSTECTOMY—THE STANDARD OPERATION.

In order to facilitate the division of the peritoneal reflections of the gall-bladder, weak novocaine solution or saline is injected underneath the peritoneum where it is reflected from the gall-bladder on to the liver. (After Wilkie.)

however carefully the operation is performed such leakage is apt to occur from time to time.

Cholecystectomy, Exploration of the Bile Ducts, and Choledochostomy for Calculous Cholecystitis. In cases of chronic cholecystitis associated with gall-stones in the absence of any serious complications

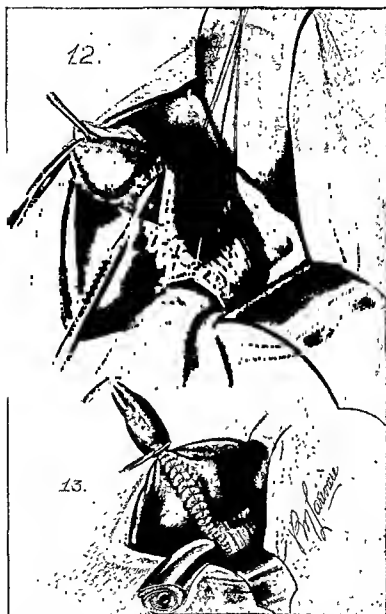


FIG. 186—CHOLECYSTECTOMY—THE STANDARD OPERATION.

The gall bladder fossa is covered over by stitching the cut edges of the peritoneum together by a series of interrupted sutures. Drainage is provided.

such as advanced jaundice, it is the practice of most surgeons to explore the biliary passages and then to excise the gall-bladder. All are agreed as to the value of cholecystectomy, but there is considerable divergence of opinion as to what in fact constitutes a satisfactory exploration of the bile ducts. Some surgeons maintain that a naked-eye inspection of the ducts combined with palpation is all that is necessary to detect any gross anatomical or pathological changes; others perform aspiration also, and their decision as to whether or not the common duct should be incised is guided by the appearance of the bile withdrawn in the syringe. If the bile is muddy, it is presumed that it is infected; if it is clear, that it is normal. Others, notably Mirizzi (*Lancet*, 2:366, 1938), perform immediate (operative) cholangiography with the object of reducing the number of explorations of the common bile duct to a minimum and of limiting such explorations to only those cases which show irrefutable X-ray evidence of stone or stricture. Others, again, during the process of cholecystectomy explore the ducts through the open end of the cystic duct, or if the cystic duct is narrow this is slit open to accommodate the various instruments which have to be passed down it. I maintain that there is only one sure method of examining the biliary passages satisfactorily, and that is by making an incision into the anterior wall of the supraduodenal portion of the common bile duct and thoroughly exploring the bile ducts from within by means of suitable forceps, probes, scoops, suction tubes and so forth. At the completion of such an exploration the gall-bladder is excised and external biliary drainage is effected by means of a T-tube sewn into the common duct. My advocacy of this systematic routine method of exploration is based upon the following:

1. In cases of chronic cholecystitis associated with gall-stones, calculi are found in the bile ducts more frequently than is commonly believed. A fair assessment of the incidence based on autopsy examinations and operative findings would be 30 per cent.

2. In fully 70 per cent of cases the so-called "recurrent" stones in the bile passages are actually stones which have been overlooked at the first or at some subsequent operation. However, it should be remembered that in certain cases of long-standing cholangitis with muddy infected bile, stones—or rather putty-like pigment masses—may be formed in the bile ducts even after the diseased gall-bladder

has been excised and the ducts efficiently explored and then drained for a considerable period. The stones may even recur after a second or third operation, but the prospect of effectual cure is nevertheless good if the patient can pluck up enough courage to undergo a further operation in spite of previous disappointments.

3. In spite of most scrupulous and methodical digital palpation of the ducts it is often impossible to detect minute calculi, biliary sand, or even large conglomerate masses of soft pultaceous pigment stones.

4. Unless the duct is probed, stones impacted in the lower reaches of the common bile duct may be mistaken for indurated pancreatic nodules or inflamed lymphatic glands.

5. Although visual examination of bile aspirated from the common bile duct will often yield valuable information, it may at times be very misleading. Turbid bile is usually purulent, but clear bile also may be purulent. It is common experience to find that the first syringeful withdrawn is clear bile, but that the second is turbid bile which has been pent up in the dilated retroduodenal portion of the duct.

6. In cases of stones the appearance of the gall-bladder and of the ducts is no sure guide as to the presence or absence of stones in the bile ducts. The gall-bladder may appear healthy and the cystic duct be very narrow; in fact so narrow that it is inconceivable that even minute calculi could have passed through it into the common duct. Yet, I have on occasions encountered stones—minute faceted ones—or biliary sand in such cases. If the common bile duct is enlarged and its walls are thickened and pale, stones will often be found when it is explored; but, on the other hand, in some cases of calculous cholecystitis, even when the duct is of normal size and is of a sea-green colour, it may on exploration be found to harbour a few calculi or inflammatory débris.

7. The only efficient method of draining the extensive and ramifying intra-hepatic radicles which are so often concomitantly infected along with the gall-bladder is by means of choledochostomy.

8. External biliary drainage affords an opportunity of ascertaining by post-operative cholangiography and also by macroscopical, microscopical and chemical investigation of the bile the effects of such drainage of the biliary system. It is, for instance, common to find that the turbid bile which for the first few post-operative days escapes

through the T-tube will after a varying period become clear and wholesome, indicating that such drainage has been effective and that the T-tube is no longer required.

9. In my experience no complications such as stricture of the common bile duct, laceration of the duct or the re-formation of calculi can strictly be attributed to the use of a T-tube, and provided that the lower reaches of the duct are patent there is no external discharge of bile when the tube is withdrawn. Convalescence is therefore not unduly prolonged, in fact it may be shorter and more tranquil than when such drainage is not employed.

10. It has been the experience of a large number of surgeons, including Judd, Waltman Walters, Walton, Lahey and Saint, as well as myself, that the immediate and late results of cholecystectomy combined with choledochostomy are infinitely superior to those of cholecystectomy alone for the type of case under discussion.

11. The death-rate following the combined operation is not higher than that which follows simple excision of the gall-bladder, being about 2 per cent. In a consecutive series of 100 personal cases of cholecystectomy combined with choledochostomy for calculous cholecystitis which were carried out at the Southend General Hospital there were only two deaths. Where, however, this operation was undertaken in the presence of severe jaundice, the mortality was 15 per cent.

The operation is performed as follows: After packing off the viscera and inserting the Deaver retractors, the cystic artery and then the cystic duct are ligatured and divided. The gall-bladder is partially freed and is drawn over to the right and used as a tractor. The common bile duct is now isolated and the area around is packed off with waterproof squares, while two stay sutures are introduced opposite to one another through the anterior surface of the common bile duct about $\frac{1}{8}$ -inch or more apart and about $\frac{1}{8}$ -inch below the insertion of the cystic duct. These stay sutures are lifted upward while a small nick is made with a sharp-pointed knife between the sutures into the taut anterior wall of the common bile duct.

When the duct is opened, the bile which wells up is immediately aspirated by a suction tube (fig. 187). The opening in the duct is then gradually enlarged by stretching with the points of scissors until it is about one-third to half an inch in length. The ducts are now syste-

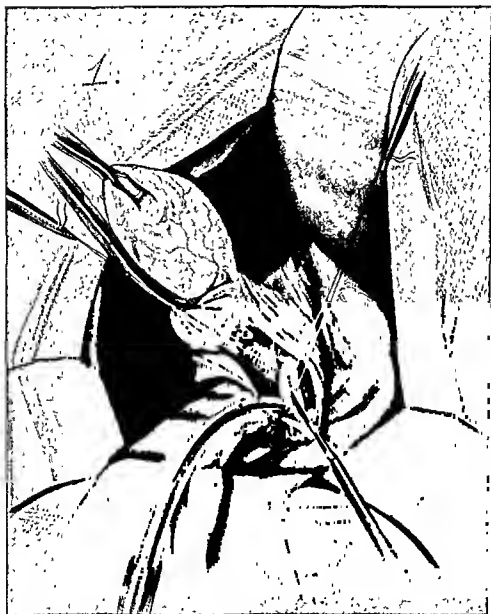


FIG. 187.—CHOLECYSTECTOMY COMBINED WITH CHOLEDOCHOSTOMY.

The common duct is being incised. Note the position of the stay sutures and of the suction tube.

matically palpated and their contents are expressed or worked toward the opening which has just been made. If any calculi can be felt in the retroduodenal portion of the duct or even in the ampulla of Vater they can usually be coaxed toward the incision in the duct and removed with forceps.

If there is much biliary sand or mud the ducts should be irrigated with warm saline by means of a small rubber catheter which is attached to a large Record syringe. Graduated sounds or gum-elastic bougies are then passed downward to ascertain whether the papilla is patent, and if this is found to be so the lower reaches of the duct, the ampulla, and the papilla itself receive a gentle stretching. It is sometimes very difficult to be sure whether the point of the sound is in fact in the lumen of the duodenum, but by gently rotating the instrument while the other hand palpates through the anterior wall of the duodenum, satisfactory information may be obtained (fig. 188).

Curved Desjardins forceps are then passed upward into the common hepatic duct and into the main branches of this duct in an endeavour to grasp any calculi which may be lurking in hidden recesses. The forceps are then passed downward into the duodenum and gently withdrawn with the blades slightly open to ensure further dilatation. When the duct has been satisfactorily dilated, a small rubber catheter is once more passed downward through the papilla into the duodenum and saline is again injected (fig. 189). If it seeps upward into the wound this will imply that the point of the catheter has not negotiated the terminal portion of the duct, and further attempts will be necessary until there is no doubt that the saline is flowing freely into the duodenum. When the point of the catheter lies in the duodenum and saline is injected, this portion of the intestine will distend with fluid (fig. 189).

My T-tube (fig. 190 [4]) or Kehr's tube suitably trimmed (fig. 190 [6]) is then inserted into the common duct and sutured into place, as depicted in figure 190. This suturing of the opening in the anterior wall of the common duct over the T-tube is effected with No. 000 plain catgut carried on a fine round-bodied needle. The long limb of the T-tube, which must be securely anchored to the abdominal wall to prevent it from being inadvertently withdrawn, is led into a small medicine bottle which is fixed to the patient's dressings or to the side of the bed.



FIG. 188.—CHOLECYSTECTOMY COMBINED WITH CHOLEDOCHOSTOMY.

A sound is passed through the opening in the common duct downwards into the duodenum. The fingers are palpating the end of the sound to ascertain whether it is lying in the lumen of the duodenum.



FIG. 189.—CHOLECYSTECTOMY COMBINED WITH CHOLEDOCHOSTOMY.

A rubber catheter is passed through the opening in the common duct downwards into the duodenum. Saline is being injected, and this somewhat distends the second portion of the duodenum.

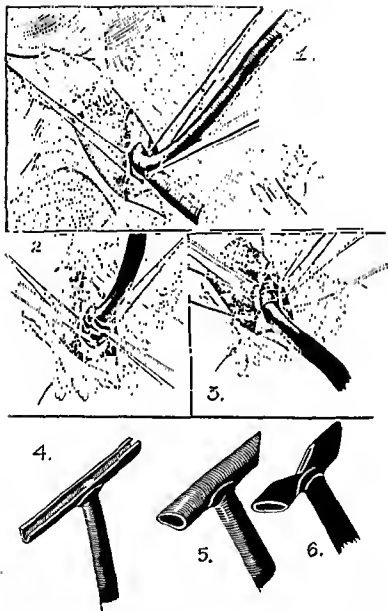


FIG. 190.—CHOLECYSTECTOMY COMBINED WITH CHOLEDOCHOSTOMY.

(1), (2) and (3) show the method of inserting the author's T-tube into the common duct.

(4) The author's T-tube.

(5) Kehr's tube.

(6) Kehr's tube suitably trimmed for insertion into the common duct.

The operation is completed by freeing the remainder of the gall-bladder from the liver bed and re-peritonising the raw surface in the liver and over the common duct (fig. 191).

In cases where the duct is enormously distended, a finger may be inserted through the incision in the duct in order to explore it thoroughly, but cases of this nature are very rarely seen nowadays.

McBurney's operation of ampullary choledochostomy will be required when a stone is firmly impacted at the termination of the common bile duct and cannot be coaxed upward into the supraduodenal portion of the duct or forced by means of sounds into the duodenum. The stone will be felt through the anterior duodenal wall as a hardened mobile nodule abutting against the tip of the sound. The duodenum is mobilised by Kocher's method, and the operative field is once again carefully packed off. A longitudinal incision about 1 inch long is then made through the anterior wall of the duodenum opposite the impacted calculus and its edges are drawn apart with Allis forceps. Any fluid which is present in the duodenum is either mopped up or removed by suction, and further contamination by duodenal juice is prevented by packing the lumen of the gut above and below the opening with swabs. The stone may be visible and may be seen partially projecting through the papilla (fig. 192 [1]). On the other hand it may be firmly impacted a little further up in the ampulla of Vater where it can be readily felt. No useful purpose will be served by attempting to dilate the papilla in order to extract the stone. It is better to incise the edges of the papilla with a knife for a short distance, after which the stone can easily be extracted. Again, this incision greatly enlarges the opening in the duct and prevents the subsequent formation of stricture at this site.

It is good practice to pass a sound through the opening which has been made in the supraduodenal portion of the common bile duct downward toward the impacted stone and then to push the stone upward to render it more accessible. A No. 8 to No. 10 Jacques catheter is then tied to the end of the sound, as shown in figure 192 (3), and is pulled upward until it emerges through the opening in the supraduodenal portion of the common bile duct. The last inch or so of this catheter should be so placed that it lies against the posterior wall of the duodenum (fig. 192 [4]). By traction on the

5.

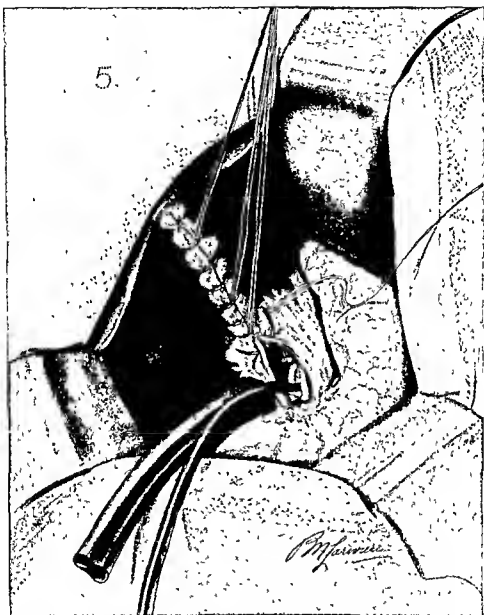


FIG. 191.—CHOLECYSTECTOMY COMBINED WITH CHOLEDOCHOSTOMY.

The author's T-tube is sutured to the common duct, a soft rubber tube is led to the foramen of Winslow, and the liver is reperitonised with a series of interrupted sutures.

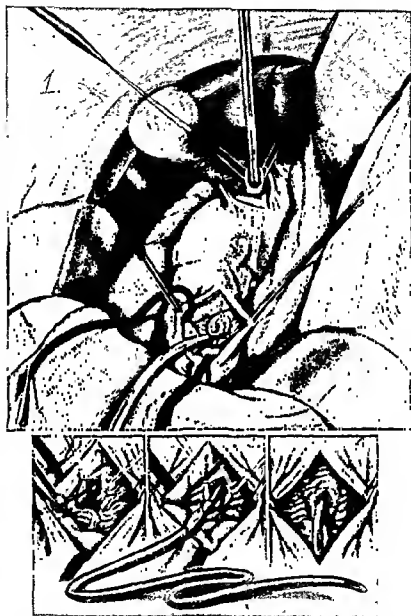


FIG. 192.—McBURNey's OPERATION OF AMPULLARY CHOLDOCHOSTOMY—THE AUTHOR'S MODIFICATION.

Allis forceps the wound in the duodenum is rendered transverse and is very carefully closed in this direction, first with a Connell stitch of fine silk and then with a seromuscular continuous stitch which invaginates the suture line. A few interrupted sutures of fine silk

are inserted to reinforce the suture line and an omental graft is stitched over the sutured gut to afford added protection.

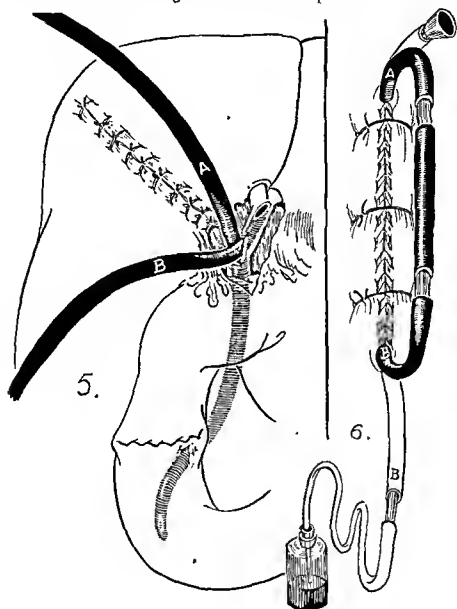


FIG. 193.—MCBURNEY'S OPERATION OF AMPULLARY CHOLEDOCHOSTOMY—THE AUTHOR'S MODIFICATIONS.

Another Jacques catheter of the same diameter is introduced into the common hepatic duct, after which both tubes are sutured to the margins of the duct (fig. 193).

The tube that lies in the common hepatic duct is used for draining bile and for taking samples of the bile from time to time, whereas the other tube which lies in the duodenum may be used for feeding purposes. For a few hours every day the two tubes may be connected, as shown in figure 193 (6).

Kocher's operation of transduodenal choledochostomy is indicated when a stone or stones become wedged in the ampulla of Vater or in the portion of the duct immediately proximal to this. Here again the duodenum is mobilised and the anterior wall of the second portion of the gut incised and widely retracted. The papilla and the posterior duodenal wall just below it are palpated and any localised induration would suggest the site of the impacted stone. Although the stone is often difficult to locate, its position is sometimes indicated by a small mound just above the ampulla. The folds of mucous membrane over this little projection can be put on the stretch with the fingers and thumb and a longitudinal incision made with a scalpel through the posterior duodenal wall, through the sclerosed pancreatic tissue and through the anterior wall of the duct before the calculus can be seen (fig. 194 [1]).

Stitches are then taken on each side of the incision through all the tissues between the stone and the posterior duodenal wall. These stitches will therefore embrace a portion of the duct, the compressed pancreatic tissues which lie between the duct and the posterior duodenal wall and the duodenal wall itself (fig. 194 [2]).

As the incision is lengthened to permit of easy extraction of the stone, additional sutures are introduced into the newly cut tissues, the ends not being tied but being held by hæmostats and used as retractors. As soon as the stone is removed these sutures are carefully tied and the new opening in the duct is inspected to make sure that it is ample and patent. The placing of a stitch at the upper and lower ends of this wound is never omitted.

A special T-tube is then introduced into the opening in the supraduodenal portion of the common bile duct. The short upper limb is placed in the common hepatic duct, while the long lower limb—and it may be 5 inches or more in length—is gently guided down the common bile duct and led through the new opening into the duodenum (fig. 194 [3]). When it is seen that the end of this tube is well placed, the incision in the duodenum is closed transversely, as

has been described, after which the edges of the incision in the supra-duodenal portion of the common bile duct are snugly approximated around the long issuing limb of the T-tube (fig. 194 [4]).

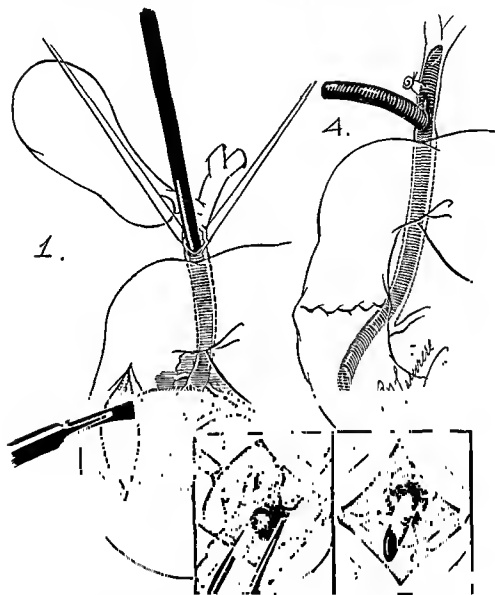


FIG. 194.—Kocher's OPERATION OF TRANSDUODENAL CHOLEDOCHOSTOMY.
The author's special T-tube is being used.

The long limb of the T-tube is brought through the abdominal wound, stitched to the skin and led down into a bottle which receives

the bile and which is placed at the side of the patient's bed. This cumbersome-looking T-tube is left in situ for two or three weeks to ensure that the lower reaches of the duct and the new opening into the duodenum receive adequate dilatation. Contrary to what might be expected, it is very easily withdrawn without producing any trauma to the opening in the common bile duct, as the upper limb which lies in the common hepatic duct is very short, soft and flexible.

6. **Moynihan's operation of rotation of the common bile duct followed by choledochostomy.** This operation of Moynihan's is indicated in certain cases where there is obstruction of the supraduodenal portion of the common duct by an impacted calculus or calculi, where the minimum amount of operative interference is advisable owing to jaundice and poor condition of the patient, and where the gall-bladder is small and shrunken and numerous adhesions obscure the cystic and common ducts. In such cases the necessary freeing of adhesions and time-consuming dissection which is usually necessary to expose the common bile duct may be too great a strain on the patient's resources. In this operation the adhesions are ignored, yet the duct is made more accessible and can be opened and drained with a minimum amount of interference.

After isolating the operative field the surgeon's left hand is passed transversely inwards in front of the pylorus and above the stone along the gastro-hepatic omentum. When the hand is well placed the fingers are flexed and the wrist and hand are bent over to the patient's left, with the result that the common duct is twisted up into the wound and readily incised.¹

When the surgeon's thumb is placed over the duodenum, as is shown in figure 195, the stone or stones can be palpated in the duct between the fingers and the thumb. Two pairs of stay sutures are then introduced in the longitudinal axis of the duct, and an incision is made between them and the stones are extracted from the ducts.

The exploration and drainage of the duct do not differ in any essential detail from that already described except that on cutting the loops of the stay sutures four sutures are immediately available for infolding the duct around the trough end of a T-tube. The gall-bladder is not excised.

7. **Lateral Choledcho-Duodenostomy.** In this operation a side-to-side anastomosis is performed between the dilated common duct

¹ Moynihan, *Abdominal Operations*, 2nd ed., 1926, p. 360.



FIG. 195.—MOYNIHAN'S OPERATION OF ROTATION OF THE DUCT

and the first part of the duodenum. The main indication for this operation is when the duct is obstructed low down in the retro-duodenal portion and is inextricably welded to the pancreas. It may also be advised in some cases of chronic sclerosing pancreatitis in which cholecystectomy has been obligatory.

The operation is only possible when the duct is greatly dilated and when the obstruction is situated in the retro-duodenal portion of the duct, and where there is no biliary fistula. The operation is performed as follows: The duodenum is mobilised by Kocher's method and the anastomosis is made at the point where the common duct and duodenum can most easily be approximated. Where possible the parts to be anastomosed should be held by traction sutures. The incision should be made transverse in the duct and vertical in the duodenum. The parts are approximated and a continuous seromuscular suture of No. 00 chromic catgut or fine silk is applied. The posterior through-and-through all-coats hæmostatic suture of No. 00 twenty-day chromic catgut draws together the posterior margins of the wound in the duodenum and the duct, and this is carried anteriorly to the starting point. The seromuscular stitches are then again taken up and completed anteriorly. A few Halsted stitches are inserted anteriorly to relieve tension and the suture line is surrounded with an omental graft.

THE MANAGEMENT OF T-TUBES AND OTHER TUBES FOLLOWING OPERATIONS UPON THE GALL-BLADDER AND BILE DUCTS

Following excision of the gall-bladder, whether the common duct has been drained or not, it is, in my experience, most essential to drain the operative field for at least forty-eight hours by means of corrugated rubber or a soft medium-sized rubber tube. I often use a cigarette drain or a Penrose tube. To neglect this precaution in the face of current teaching cannot be too strongly condemned, as its omission may court disaster in the occasional case, for during cholecystectomy an unseen accessory hepatic duct may inadvertently be severed or the common hepatic duct may be nicked and subsequently flood the peritoneal cavity with bile, eventually giving rise to fatal peritonitis. Again, some oozing almost invariably occurs from the sutured liver bed, and in some cases of jaundice, however mild, large quantities of blood may fill the abdomen or become loculated in the sub-hepatic space. In the absence of any outlet for the escape of this blood it is very likely to become infected and produce a localised or even a generalised peritonitis for which the surgeon is almost entirely to blame.

In cases of cholecystostomy the tube which has been placed in Morison's pouch should be removed at the end of forty-eight hours. The tube which has been inserted into the gall-bladder is connected to another tube by means of a glass connector and this is led into a bottle placed beside the patient's bed. The bile which collects in this bottle is examined from time to time. Some 4 oz. of this bile diluted with tap water should be introduced into the rectum daily for the first four or five post-operative days, as this has a beneficial effect in reducing flatulence and often in aiding the bowels to work without recourse to aperients. This tube usually works loose at the end of a week or ten days, and provided the biliary passages are clear the sinus soon closes. If there is a persistent discharge of mucus it may be inferred that the cystic duct is blocked and if the discharge is of bile that the common bile duct is obstructed. In such cases 10 to 20 cc. of lipiodol should be injected through the sinus into the gall-bladder and skiagrams immediately taken. If the skiagrams show irrefutably that the cystic duct is not patent, a secondary operation, often amounting to cholecystectomy combined with choledochostomy, will be required.

In cases of calculous cholecystitis where cholecystectomy and choledochostomy have been performed, it is sometimes difficult to decide for how long the T-tube should be left in situ. In a general way it may be stated that if there is no pain, no pyrexia and no jaundice, if examination of the bile shows that pus is absent, if after clamping the tube no pain or backache is produced, and if the motions which are passed are dark brown in colour, thus indicating that bile is passing into the intestines, the T-tube may be removed at the end of seven or eight days. If the bile is muddy and malodorous, if the stools are clay-coloured, or if clamping of the tube produces colic, the tube should not be removed. In such cases it would be wise to take a choledochogram to determine the site and the cause of the obstruction in the common duct (fig. 196). If a stone is present, it may be possible, as originally suggested by Pribam (*Surg., Gynec. & Obst.*, 60:55, 1935), to fragment it or partially dissolve it by injecting a few cubic centimetres of equal parts of ethyl-ether and ethyl-alcohol through the tube daily for a few days, following this by the introduction of a few cubic centimetres of warm liquid paraffin in order to aid the passage of the stone into the intestine. Waltman Walters and



FIG. 196.—CHOLANGIOGRAM.

Lipiodol has been injected down the T-tube and the opaque medium can be seen filling the biliary tree and entering the duodenum (White Phillips).

Wesson (*Proc. Staff Meet. Mayo Clinic*, 12:260, 1937) gave an excellent account of a case in which a stone in the common duct was fragmented and induced to pass into the duodenum after repeated injections of ether down the T-tube and also the use of amylnitrite.

Choledochograms will reveal the presence of:

1. Any narrowing of the common bile duct and persistent pancreatitis.

2. An overlooked stone in the common bile duct.

3. Spasm or stenosis of the sphincter of Oddi.

4. Carcinoma of the ampulla of Vater or of the pancreas.

Biliary dyssynergia or dyskinesia—spastic contraction of the common bile duct sphincter—is a common cause of persistent or recurrent pain following cholecystectomy. The work of Meltzer, Lyon and Ivy indicates that a spasm or dyskinesia of the sphincter of Oddi may mechanically block the common duct and produce a stasis of bile with its attendant colic and icterus.

Delayed (or post-operative) cholangiography will aid in the diagnosis of this condition (Hicken, Best and Hunt: *Ann. Surg.*, 103:210, 1936) McGowan, Butsch and Waltman Walters (*Ann. Surg.*, 104:1013, 1936) and others recommend treatment of this condition by means of amylnitrite or nitro-glycerine (glyceryl-trinitrate), as these are the most potent drugs in causing relaxation of the choledochus sphincter. Other drugs used are belladonna and eumydrin. In all cases of pain arising some time after cholecystectomy the following measures should be tried:

1. Drachm doses of magnesium sulphate with large draughts of water daily before breakfast.

2. A teaspoonful of olive oil three times a day before meals.

3. Crystalline dehydrocholic acid, 0.25 to 0.75 gm. three or four times a day.

4. Nitro-glycerine in doses of 1/100 gr. once or twice daily, depending upon the individual requirements of the case.

RESULTS OF OPERATIVE TREATMENT

1. **For Chronic Cholecystitis.** The mortality of cholecystectomy in cases of chronic cholecystitis with or without gall-stones varies from 0.5 to 3 per cent. Thus in Wilkie's series (*Lancet*, 1:751, 1934) of

341 cases there were only 5 deaths—1.4 per cent, and in Judd and Priestley's larger series (1932) of 579 cases the death-rate was 1.7 per cent.

The late results of cholecystectomy for chronic cholecystitis show that in some 80 per cent of cases the patients are cured, and that in 15 per cent there is considerable improvement. Sanders (*Ann. Surg.*, 92:376, 1930) recorded 352 cases of excision of the gall-bladder for chronic diseases with 84 per cent of good results.

Judd and Priestley (*J. Am. M. Ass.*, 94:887, 1932) showed 84 per cent good results with cholecystectomies and only 60 per cent good results with cholecystostomies. In 17 per cent of calculous and 12 per cent of non-calculous gall-bladders a second operation was performed after cholecystostomy.

The unsatisfactory results are due in many instances to imperfect primary operations in which stones remain undetected in the common duct, to the advent of chronic sclerosing pancreatitis or chronic hepatitis, to faults in operative technique such as not peritonising the raw surface of the ducts and of the gall-bladder fossa, to trauma of the ducts at operation, and to the presence of other chronic visceral lesions, notably chronic appendicitis, which were overlooked at the original operation. Some 15 per cent of patients have post-operative flatulence, distaste for fats, chronic dyspepsia, and occasional bouts of biliary colic due to biliary dyskinesia or to the presence of pigment stones. In cases in which colic develops after operation treatment should be along the lines already discussed. If, however, jaundice supervenes, further operative interferences will be necessary in many cases, as this is suggestive of the presence of stones ("recurrent" calculi) or the development of a stricture of the common duct. As a general rule it may be stated that the grosser the gall-bladder pathology the better the results of the operation. The late results are on the whole very encouraging. There is an increase in physical energy, freedom from "rheumatism," an improved appetite, and any cardiac disability which was present before operation rapidly decreases and may even disappear entirely.

For the reasons already enumerated cholecystostomy is now rarely performed for chronic cholecystitis.

2. **For Acute Cholecystitis.** Heuer (*Ann. Surg.*, 99:881, 1934) in a summary of 1,066 cases of acute cholecystitis found a general mor-

ality of 8 per cent. In Glenn's series (*Surg., Gynec. & Obst.*, 69:431, 1939) of 219 cases the operative death-rate was 3.17 per cent. There is a wide variation in the individual death-rates as reported from different surgical clinics. In some instances the mortality has been as low as 2 per cent, whereas in others it has been as high as 15 per cent. If cholecystectomy is performed during the first forty-eight hours of the onset of the acute attack, the mortality should not exceed 3 per cent. The mortality appears to be higher between the third and tenth days.

The operative mortality of cholecystectomy following a course of so-called delayed treatment is usually estimated at 10 per cent. It is difficult to arrive at an average mortality for cholecystostomy for this disease. If it is performed as a routine procedure it is low; if, on the other hand, it is reserved only for desperate cases the operative mortality is high, *i.e.*, about 20 per cent. Thus in Eliason and Erb's series (*Ann. Surg.*, 100:460, 1935) of twenty-four cases, there were three deaths—a mortality of 12.5 per cent.

3. For Stones in the Common Duct. (a) *Jaundice absent*. Cholecystectomy with choledochostomy—the mortality is about 2 to 3 per cent.

(b) *Jaundice slight*. Cholecystectomy with choledochostomy—mortality about 3 to 5 per cent.

(c) *Jaundice severe, but dark bile aspirated from the common bile duct or from the gall-bladder*. Cholecystostomy with or without choledochostomy or choledochostomy alone—mortality about 10 to 15 per cent.

(d) *Jaundice very severe with marked back-pressure on the liver and white bile aspirated from the common bile duct*—mortality over 30 per cent.

CAUSES OF DEATH AFTER OPERATION UPON THE BILIARY SYSTEM

The death-rate following operations upon the biliary tract depends largely upon the presence of complicating factors and errors in operative technique. Among these would be: (1) chokemia; (2) intense jaundice; (3) sub-acute pancreatitis; (4) gangrene and perforation of the gall-bladder; (5) peritonitis; (6) cholangitis; (7) lack of care in the selection and preparation of patients for operation; (8)

rough handling of and injury to the liver, bile ducts and blood vessels and exposure and chilling of the liver.

Fully one-half of the deaths which follow operations upon the biliary tract are caused by chokemia. The remainder are due to hæmorrhage, peritonitis and chest complications.

The important subject of "liver deaths"—the hepatorenal syndrome—following operations upon the gall-bladder and bile ducts has been most ably discussed by Gordon Heyd (*Texas State J. M.*, 33:546, 1937).